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Morphometric Analysis of the Dentition From Bronze Age Tell Leilan, Syria: A Contribution to the Dental Anthropology of Ancient Mesopotamia

by

Scott D. Haddow ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Arts.

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The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Morphometric Analysis of the Dentition From Bronze Age Tell Leilan, Syria: A Contribution to the Dental Anthropology of Ancient Mesopotamia" by Scott D. Haddow in partial fulfillment of the requirements for the degree of Master of Arts.

Abstract

The skeletal remains of twenty-one adult and thirty-eight subadult humans were recovered over the course of excavations between 1979 and 1989 from the Bronze Age site of Tell Leilan in northeastern Syria by Dr. Harvey Weiss of Yale University. Non-metric, or discrete trait, analysis reveals that the Tell Leilan permanent and deciduous dentitions exhibit largely Western Eurasian, or Caucasoid, morphological characteristics, while metric analysis reveals a Total Crown Area (permanent = 1189 mm^2; deciduous = 497 mm^2) that is slightly larger than more recent Near Eastern and modern European dentitions. The results of the Near Eastern TCA comparison reveal and confirm the pattern of dental reduction observed in other regions and time periods of the world.

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Chapter 1

Introduction

Protruding from the soft tissues inside the oral cavity, the dentition is the only hard tissue of the human body directly exposed to the environment throughout life. As such, teeth are used as mechanical aids to chew and digest food, and in some cases as tools for processing materials in order to make other tools. In addition to mechanical stress, the dentition is also subject to pathological afflictions as a result of certain environmental factors. In evolutionary terms, the modern human dentition has been subject to a high degree of morphological variation brought about by biological and behavioral changes over thousands of years.

By nature of its enamel structure, the dentition is the most durable component of the human body, and thus, the most likely to survive under harsh environmental conditions long after the body has ceased to live. In such environments, even bone can be reduced to dust. In addition, teeth cease to develop during an individual's third decade, thus preserving evidence of environmental insults suffered early in life. Such insults would be obliterated in bone, which continues to remodel itself even after growth stops. For the bioarchaeologist, then, the dentition is often the only material remains of a human life available for analysis, and usually the best source for information on health and genetic affiliations. As a result of this, and its unique position in the living body, the study of the human dentition has become an essential facet of bio-

anthropological and bio-archaeological research. Today, the study of modern and archaeological human dentition, or Dental Anthropology, is a well-established sub-discipline of Physical Anthropology defined by Simon Hillson (1996:1) as "a study of people (and their close relatives) from the evidence provided by teeth". Such research may yield information on a variety of topics such as growth and development, health, diet, occupational activity, and biological affinities. This information can be used in studies of individuals as well as populations.

The analysis of the dentition may take many forms, depending on the nature of the inquiry. For example, studies of tooth wear patterns may yield information on diet and environmental conditions, while examinations of carious lesions, periodontal disease, and other forms of dental pathology may allow inferences to be made about overall, as well as oral health. Because the pattern and timing of human dental development is relatively well-understood, studies of archaeological dentitions may also yield information about the overall growth and development of individuals and populations. Each of these analyses complements the other, as the relationship between diet, health and the environment is often interrelated. Finally, morphometric analysis of the shape and size of the dentition, when compared with similar studies, can be used to infer biological relationships between populations, as well as to track evolutionary variation in dental size related to changing diets and settlement patterns.

The aim of the present study is to establish new non-metric and metric dental data for ancient Mesopotamia, and to compare these data with similar studies of Near Eastern populations in order to contribute to our understanding of

the dental development of, and the genetic relationships between, living and archaeological Near Eastern populations. At present, however, there are few published analyses of the dentition for any of the populations that once comprised the ancient civilizations of Mesopotamia. The materials for this study derive from Tell Leilan, a Bronze Age site in northern Mesopotamia (modern northeastern Syria), and are comprised of adult and subadult individuals. Chapter 2 describes the historical development of the study of human dental size and shape; Chapter 3 provides the culture-historical context for this study, and Chapters 4 and 5 present the results of the non-metric and metric analyses, respectively. Chapter 6 provides a summary of the research results and conclusions.

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Chapter 2

The History of Dental Morphometrics

Introduction

Observations of teeth and their variation have existed in Western literature from as early as the days of Classical Greece. The *Corpus*, by Hippocrates (460-375 BC), is one of the oldest written sources to describe the dentition, while Aristotle (384-322 BC), in *De generatione animalium*, discussed the dentition, along with the rest of the human body, in comparative terms (Alt et al. 1998). Roman authors such as Pliny (23-79 AD) and Galen (129-189 AD) continued to observe and describe the dentition, and, after the fall of the Roman Empire, Islamic scholars managed to compile and preserve many of these ancient scientific works, ultimately perpetuating classical knowledge of anatomy and medicine until these sources were rediscovered by the West in the Middle Ages (Alt et al. 1998).

The modern study of the human dentition begins with the work of nineteenth century geologists and biologists (Dahlberg 1991). Charles Lyell's establishment of the earth's antiquity paved the way for radical concepts such as Charles Darwin's theory of evolution, which influenced scientists in a diversity of fields, from zoology and biology, to comparative anatomy and paleontology. Richard Owen's *Odontography* (1840-1845) was the first comprehensive monograph on the comparative dental anatomy of living and fossilized animals and remained the foundation of for subsequent comparative investigations for many years (Alt et al. 1998). In the late nineteenth century and early twentieth

century, teeth became recognized as valuable tools for assessing ontogenetic and phylogenetic questions such as mammalian development and evolution (Alt et al. 1988). Researchers such as E.D. Cope (1840-1897), H.F. Osborn (1857-1935), and W.K. Gregory (1876-1970), were pioneers in the study of growth and evolutionary factors, establishing much of the framework for future inquires (Dahlberg 1991; Alt et al. 1998). The beginnings of the independent development of dental anthropology are marked by the emergence of population-based studies of particular ethnic groups or fossil assemblages during the early half of the twentieth century (Hillson 1996). These types of studies were known as "odontographies", and examples of them include the analysis of the dentition of Australian Aborigines by Campbell (1925), Bantu tribesman of Africa by Shaw (1931), and Chinese *Homo erectus* by Weidenreich (1937; cited in Hillson 1996). A.A. Dahlberg's paper, *The Changing Dentition of Man* (1945), further refined and developed the concept of population studies based on the teeth and set the stage for a dramatic increase in the number of anthropological dental studies in the second half of the twentieth century (Dahlberg 1991; Hillson 1996). Later, D.R. Brothwell's (1963) edited symposium volume, *Dental Anthropology*, established the scope of dental anthropological research, and included papers on tooth morphology, growth and development, and dental pathology in both living and archaeological populations .

Today, dental anthropology is considered a sub-field of physical anthropology, encompassing a wide variety of research pursuits. While some researchers concentrate on post-eruptive changes such as tooth wear and cultural

modification (reviewed by Milner and Larsen 1991), others concentrate on pathological afflictions of the dentition such as caries and periodontal disease (reviewed by Brothwell 1963; Koritzer 1973). Such research has revealed a great deal of information on diet and habitual activities involving the teeth. Another avenue of inquiry is the study of developmental patterns in the dentition, including tooth germ formation and developmental defects (reviewed by Hillson 1996). Finally, researchers interested in the genetically controlled aspects of the dentition study tooth shape and size (reviewed by Kieser 1991; Scott and Turner 1997). This last aspect of dental anthropology, tooth shape and size, generates more literature than any other aspect of dental anthropology (Hillson 1996; Mayhall 2000), and is the subject of the present study. This morphometric approach to the study of human dentition may provide numerous insights into cultural, biological and ecological aspects of human behavior, environments, and living conditions in the past, as well as the present.

Dental Non-Metrics

Human dentitions exhibit highly heritable non-metric morphological crown and root traits that vary within and between populations. The term non-metric implies structural variations of individual crown and root forms that are visually scored in two ways: “presence-absence” characters such as furrow patterns, accessory ridges, supernumerary cusps and roots, or, as differences in form such as curvature and angles (Hillson 1996; Scott and Turner 1997). Numerous studies have demonstrated that morphological dental forms respond to microevolutionary forces of admixture (e.g. Turner 1969), mutation (e.g. Morris

et al. 1978), genetic drift (e.g. Turner 1969; Scott and Dahlberg 1982), and selection (e.g. Dahlberg 1963; Scott and Turner 1988), thus evincing their high degree of genetic control. From a phylogenetic viewpoint, non-metric dental traits are visible in living and fossil hominoids and hominids (e.g. Gregory and Hellman 1926; Swindler 1976; Wood and Abbott 1983), while patterns of geographic variation in tooth crown and root traits have been observed in anatomically modern human populations (e.g. Dahlberg 1963; Scott 1980; Mizoguchi 1985; Scott and Turner 1997). Because of these features of the dentition, analysis and comparison of dental non-metric traits is an excellent tool for assessing relationships between populations.

The earliest study of human dental morphological variation comes from the dental anatomist Georg von Carabelli, who published a paper in 1842 on his observations of a small mesiolingual accessory cusp on the upper molars (cited in Scott and Turner 1997). Carabelli noted the common occurrence of this cusp in European dentitions. Today, this unassuming tubercule bears his name, and it is one of the most well-known morphological variants of the human dentition. In 1920, Aleš Hrdlička published a study of shovel shaped incisors in the *American Journal of Physical Anthropology* which is considered by many as the foundation, or starting point, of the modern study of human tooth morphology (Scott and Turner 1997). Hrdlička was the first to attempt to classify the degree of expression of a morphological dental trait and to examine its variation among human populations (Turner et al. 1991; Alt et al. 1998). His research on the geographic distribution of shovel shaped incisors lent increasing weight to the

argument for the close biological relationship between Asians and Native Americans. W.K. Gregory, in his major work *The Origin and Evolution of the Human Dentition* (1922), furthered the comparative study of human dentition by noting that, among other things, apart from some minor variations, differences in morphology between human populations were minimal (cited in Scott and Turner 1997). Some minor variations observed by Gregory included shovel shaped incisors, *tuberculum dentale* of the anterior maxillary teeth, molar cusp number, lower molar groove pattern, and Carabelli's cusp. Despite these advances, however, subsequent studies of dental morphological variation were far and few between until the arrival of two key researchers, A.A. Dahlberg and P.O. Pederson, in the mid-twentieth century.

Both originally dentists, Dahlberg and Pederson made great strides in the advancement of dental morphological studies during the second half of the twentieth century; Dahlberg, through the collection and study of large numbers of dental casts from living White and Native Americans, and Pederson, through his landmark studies of living and archaeological Greenlandic Eskimo dentitions (Hillson 1996). Working together, Dahlberg and Pederson also helped organize several Dental Morphology Symposia beginning in the mid-1960s. Over the years these symposia have served to promote the study of tooth variation and the discipline of dental anthropology as a whole (Dahlberg 1991; Hillson 1996). Dahlberg promoted the comparative study of dental morphology unceasingly through these symposia, and through his own research (e.g. Dahlberg 1963). Through his introduction and distribution of a series of 17 standardized reference

plaques which presented the classification of permanent dental traits and their variations, Dahlberg also played a role in overcoming one of the major problems of the study of tooth morphology: the classification of dental morphological traits and standardization of scoring procedures (Dahlberg 1991; Scott and Turner 1997; Mayhall 2000). Some of the traits represented in Dahlberg's series include plaques for upper incisor shoveling and double-shoveling, Carabelli's cusp on the upper first molar, hypocone on the upper second molar, and the protostylid.

Building on Dahlberg's efforts to standardize the classification of permanent dental morphological variation, workers at the Dental Anthropology Laboratory of the Arizona State University developed a standardized procedure for the graded scoring of key morphological traits of the permanent dentition, complete with reference plaques and detailed descriptions of trait expression for each scoring grade (Turner et al. 1991; Mayhall 2000). Known as the Arizona State University (ASU) system (Fig. 2.1), this procedure standardizes scoring for over 40 crown, root, and jaw variants, many of them based on the earlier works of Hrdlička and Dahlberg. Due to the comprehensiveness of the system and the widespread distribution of the reference plaques, the ASU system is the most widely employed system in use today and is also the recommended standard for scoring dental non-metric traits (Buikstra and Ubelaker 1994). In Japan, Kazuro Hanihara and co-workers devised similar reference plaques and scoring procedures for the deciduous dentition and, at the same time, developed and defined the characteristics of the "Mongoloid dental complex" based on living

populations (Hanihara 1963, 1968; Hanihara and Minimidate 1965). Unfortunately, these plaques are not widely available (Mayhall 2000).

While many comparative studies of dental morphology have demonstrated that the distribution of certain trait expression frequencies such as shoveling and Carabelli's cusp often pattern along major geographical subdivisions of humankind (e.g. Swindler 1976; Brues 1977), more recent studies have shown that the expression frequencies of such traits are not as discriminating between world populations as previously believed (Scott 1980; Turner and Hawkey 1998). As such, Turner and Hawkey (1998) have recommended that, whenever possible, no less than all traits in the ASU system be employed in assessment of genetic affinities. Sophisticated analyses of large numbers of traits can be analyzed profitably through the use of multivariate statistics which allows discernment of finer levels of biological distance between populations (Scott and Turner 1997). Such studies are commonly used to assess specific research questions such as the synchronic biological relatedness of segments of a particular society (e.g. Johnson and Lovell 1994), or diachronic changes in trait expressions in a particular region (e.g. Lukacs and Hemphill 1991).

Dental Metrics

Another aspect of human dental variation is tooth size. Human dentitions exhibit both synchronic and diachronic variation in tooth size. This variation is measured directly and is thus considered metric. The observation of tooth size has become one of the most common subset of anthropometric measurements of fossilized and living hominids (Kieser 1990), largely due to their increased

longevity in archaeological contexts, and to the ease with which they may be observed in living populations. While there are several commonly observed dental measurements, tooth crown length and width are by far the primary dimensions employed by odontometrists (Kieser 1990). These measurements have provided scientists of many disciplines with ample data for a diverse range of research interests. Phillip Tobias, in his forward to J.A. Kieser's *Human Adult Odontometrics* (1991), laments the lack of historical knowledge on the origin of dental metric studies. We do know, however, that, as with studies of tooth shape, the study of tooth length and width began in the late nineteenth and early twentieth century with the works of early evolutionary biologists and anthropologists who were concerned with phylogenetic and racial variation in tooth size (e.g. Fowler 1885; Bateson 1894; Hrdlička 1911).

The methods for observing tooth length and width, and the terminology used to describe them, have often varied between researchers over the years (Wolpoff 1971; Kieser 1991). Tooth length is usually referred to as the mesiodistal (MD) diameter, while tooth width refers to the buccolingual (BL), or faciolingual, diameter. One of the most commonly accepted methods in recent years for measuring tooth length and width, and the method employed in the present study, is that originally described by Moorees (1957) and Wolpoff (1971a) and summarized by Mayhall (1992, 2000). In this method, mesiodistal measurements are taken parallel to the occlusal plane of the tooth using a sliding caliper, the points of which are placed at the maximum mesial and distal ends of the tooth, rather than at the mesial and distal contact points (Fig. 2.2). The

maximum buccolingual diameter is then taken perpendicular to the plane used for the mesiodistal measurement. It is important that researchers engaging in odontometric observations of the dentition make explicit their method of measurement if comparative studies of tooth size are to be carried out.

An approximation of the occlusal surface area of a particular tooth within a population may be derived by multiplying its buccolingual and mesiodistal diameters. Then, by summing the crown areas for all teeth on one side of the dental arcade, the Total Crown Area (TCA) for a skeletal sample may be obtained. Alternatively, the Molar Crown Area (MCA) is obtained by summing the crown areas for only the molar teeth on one side of the dental arcade, and is often used in studies of archaeological dentitions where the anterior teeth are often missing. Many studies have employed the total crown area (TCA), and/or the molar crown area (MCA) as a figure for comparing tooth size variation (e.g. Brace 1980; Lukacs 1985; Brace et al. 1987). Wolpoff (1971b) states that crown areas most closely approximate the total functional occlusal size of the dentition. Thus, crown area is the actual trait which natural selection acts upon (Brace 1980); making TCA and MCA, as single discrete values, highly useful for comparing interpopulational variation in tooth size.

One of the main achievements of such comparative studies of archaeological and living human dentitions has been the documentation of a reduction in the overall size of the dentition, especially during the post-Pleistocene period (Wolpoff 1971a; Calcagno 1989). Much of our knowledge of dental reduction trends comes as the result of the pioneering work of C.L. Brace

who has published numerous dental metric studies for several regions of the world (e.g. Brace 1963, 1964, 1978, 1980; Brace et al. 1987, 1981). While Brace (1964) has proposed a theory of relaxed selective pressure known as the Probable Mutation Effect to account for this reduction trend, many researchers dispute his theories (e.g. Macchiarelli and Bondioli 1984, 1986; Calcagno 1989; Gibson and Calcagno 1989). Most scholars do agree, however, that an overall reduction in tooth crown size is likely to be observed in populations moving from nomadic hunting and gathering subsistence modes to more sedentary agricultural modes (e.g. Dahlberg 1963; Sofaer 1973). In fact, numerous studies have demonstrated that the rate and extent of hominid dental reduction was at its most profound during the Post-Pleistocene, precisely the time period during which the transition in subsistence modes occurred (Macchiarelli and Bondioli 1986; Calcagno 1989; Reddy 1992).

To date, documentation of dental reduction trends in the permanent dentition based on odontometric observation of archaeological populations has been achieved in a number of areas of the world for specific periods of time (e.g. post-Paleolithic Asia: Brace 1978, Lukacs and Hemphill 1991; Upper Paleolithic-Mesolithic Europe: Frayer 1977, 1978). However, with the exception of works by Lukacs (1981) and co-workers (Lukacs and Hemphill 1991), and Smith (1978), studies of deciduous dental metrics are extremely rare in the literature. More work in regions and time periods of history previously unexamined by dental anthropologists will enable researchers to more accurately understand the evolutionary processes involved in hominid dental reduction (Calcagno 1989).

Summary and Conclusions

The nature of its enamel structure makes the dentition more durable even than bone, and thus the more likely to survive the harsh conditions of the post-depositional environment. As a result, teeth often make up the majority of material available for study by anthropologists and archaeologists. Indeed, many hominid phylogenetic theories are based largely on fossilized teeth (Kieser 1990; Alt et al. 1998). Because of the ease with which the dentition can be observed, and of the increasing number of fossil teeth available for analysis, evolutionary studies based on the variation of hominid dentitions became increasingly common in the twentieth century. These studies have focused on two primary aspects of dental variation: tooth shape and tooth size, i.e., dental morphometrics. Among other things, the study of the shape and size of the dentition can provide a great deal of information about the genetic relationships between populations, and the effects of changing settlement and subsistence patterns over time.

While the number of dental morphometric studies of the permanent dentition for specific regions and time periods of the world has increased greatly in recent years, studies of Near Eastern dentitions have lagged behind (Calcagno 1989). Morphometric analyses of deciduous dentitions are also lacking in general. While several morphological and odontometric studies of Near Eastern dentitions have been conducted (e.g. Senyürek 1952; Dahlberg 1960; Rosensweig and Zilberman 1967, 1969; Rathbun 1972; Macchiarelli 1989), these are scant and do not include any for the ancient civilizations of Mesopotamia. Due to a lack of access to new skeletal material from certain regions of ancient Mesopotamia,

mainly in Iraq, the rich cultural and biological history of the region, as depicted in the dentition, remains clouded in obscurity. New skeletal samples from this part of the world are required in order to shed light on this historically important region.

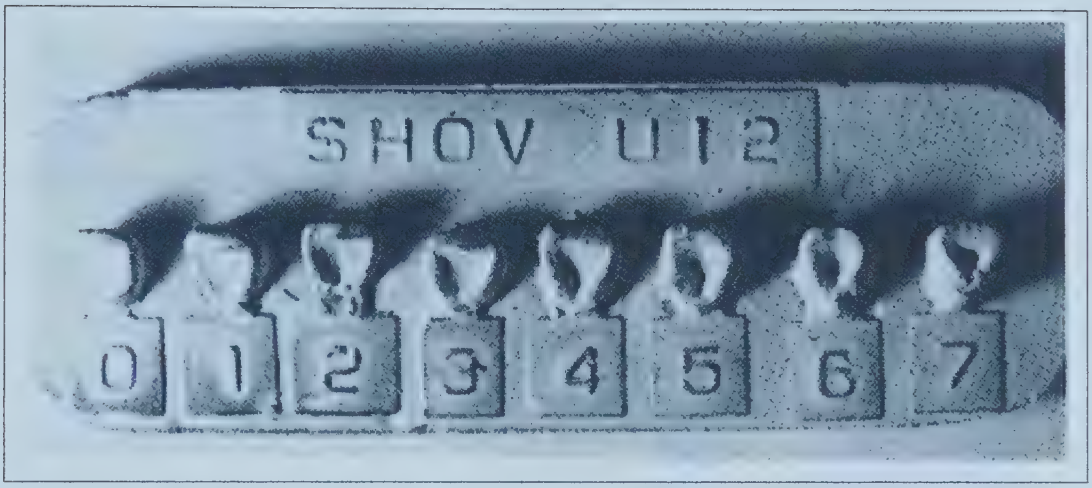

Figure 2.1. Example of an ASU dental plaque showing different grades of shoveling in the permanent upper central incisor.

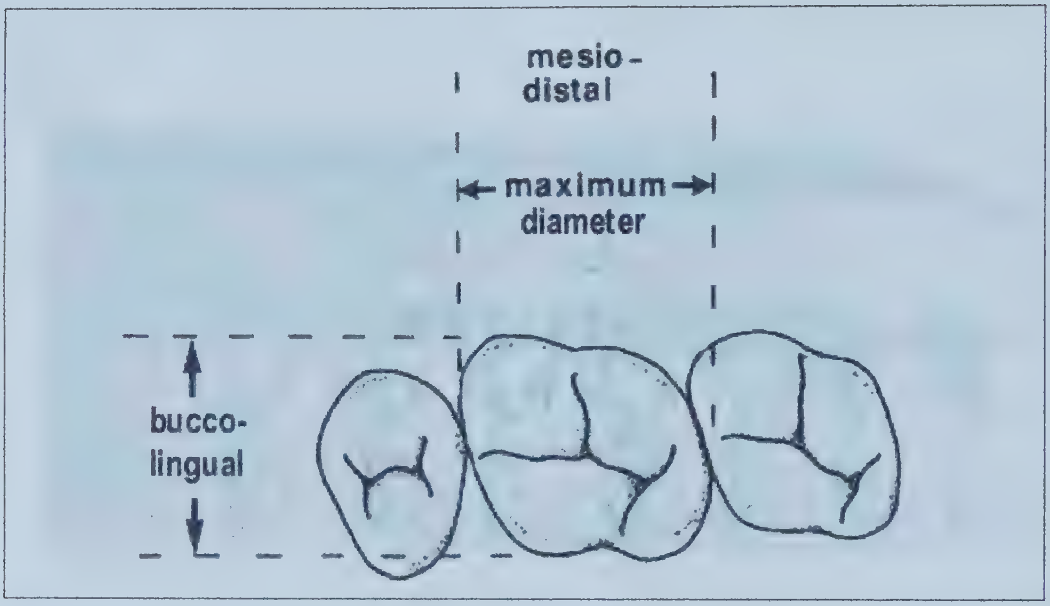

Figure 2.2. Illustration of the methods for determining the mesiodistal (MD) and buccolingual diameters (modified from Mayhall, 2000)

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Chapter 3

Tell Leilan in Geographical and Cultural Context

Introduction

Located at the articulation between Europe, Africa, and Asia, the Near East has long been central to human history. For millennia, the region has witnessed the traffic of humanity between continents as various groups have sought to eke out an existence. It was in this region, more than five thousand years ago, that the first steps toward complex, state-level societies were taken.

Situated at the geographical center of the Near East (Fig. 3.1), the region known as Mesopotamia (spanning modern Iraq, and parts of Syria and Iran) is surrounded by Anatolia (modern Turkey) to the north, Iran to the east, the Gulf states to the south-east, and Syro-Palestine (modern Syria, Israel and Jordan), through which Egypt is reached, to the west. It was this close relationship with its neighbors, in combination with the fertile nature of the land itself, that would lead Mesopotamia to become one of the earliest and most important powers in the Near East.

In the southern portion of Mesopotamia during the fourth millennium BC, settled communities began to flourish among the fertile flood plains of the Tigris and Euphrates rivers, taking advantage of the region's optimal soil conditions (Adams 1981). This vast alluvial drainage system, emptying into the Persian Gulf, was on the same scale as the Nile and Indus river systems in terms of agricultural potential. Despite the potential of the land, however, infrequent and erratic rainfall required organization and mobilization of human labor on a grand scale in order

to impose regularity and predictability on a largely unpredictable environment. By taking advantage of the annual flooding of the rivers through the construction of canals, dams and irrigated fields, the peoples of southern Mesopotamia began to produce food at an increasingly efficient rate. Apart from productive farm lands, however, the region was largely devoid of natural resources. Thus, trade with its better-provisioned neighbors became essential to the development of the southern Mesopotamian civilization which came to be known as Sumeria (Yoffee 1995).

In northern Mesopotamia, and in the hilly uplands to the east of the fertile crescent, small-scale settled food production was already well-established. Unlike the rain-starved south, northern Mesopotamia (modern northeastern Syria and northern Iraq) received rain in relatively sufficient, although often unpredictable, amounts (Weiss 1983; Wilkinson 1994). Thus dry-farming of cereal crops formed the basis of northern Mesopotamian economic life, while irrigation agriculture formed the basis of the southern Mesopotamian economy. In both regions, such well-organized subsistence patterns produced food surpluses that could be traded with neighboring groups for non-subsistence items. These surpluses also supported an increasing number of builders, artisans, traders, priests, and rulers who could devote themselves to the further development of urbanization and state-level society.

This chapter provides the geographical and cultural background of the northern Mesopotamian Bronze Age site of Tell Leilan, located in modern northeastern Syria. Consecutive excavations at Tell Leilan and contemporary sites

in the region have contributed to our knowledge of urbanization and dry-farming practices in the north and posed new theories for the events that led to the collapse of state-level society throughout Mesopotamia during the late third millennium BC. These new theories have profound implications for the study of Mesopotamian civilization, and for the study of early civilizations around the world.

Our knowledge of the origins and development of southern Mesopotamian civilization comes from a century of intensive excavation, documentation and analysis of ancient sites in the region (see for example: Perkins 1949; Adams 1970; Lloyd 1984). The ancient sites of southern Mesopotamia have tended to receive the most scholarly attention as a result of several spectacular archaeological finds at such sites as Kish (Mackay 1925; Watelin and Langdon 1934) and Ur (Wooley 1934) in southern Iraq. These and other classic works have formed the basis of our understanding of Mesopotamian civilization.

The development of urbanization and state-level society in northern Mesopotamia, however, has traditionally been less understood. Due to the academic preoccupation with southern Mesopotamian sites, and the corresponding lack of northern sites that have been systematically excavated, the region has received far less attention until recently (Weiss 1986). As such, the emergence of state-level society in northern Mesopotamia has often been attributed to the direct influence of southern Mesopotamian cultures (Weiss 1983). Based on recent excavations and improvements in epigraphic documentation however, scholars are now better able to understand the social and

economic trajectory of northern Mesopotamia. Analysis of sites in northeast Syria such as Tell Brak, Chagar Bazar, Tell Leilan and others have played an important role in the formulation of a chronological framework for the evolution of northern Mesopotamian civilization (Weiss 1983).

Southern Mesopotamia (Sumer and Akkad)

As in all regions of the world, the relationship between environment and society in ancient Mesopotamia was closely interrelated. Like other riverine civilizations such as Egypt, the inhabitants of the Iraqi floodplain region learned to control the flow of the rivers during their annual inundation through the construction of elaborate levees and canals, diverting water that irrigated huge fields set far back from the rivers themselves (Oates and Oates 1976). The earliest evidence for this practice in southern Mesopotamia dates to the sixth millennium BC (Moorey 1994). Amid a largely arid environment, this was the only subsistence pattern that would support large-scale, settled populations. The maintenance of high-yield agricultural production and its infrastructure is extremely complex and labor-intensive, however, demanding large numbers of individuals acting in a sustained and coordinated fashion.

As food production in the south increased, so did the populations that were supported by it. Agricultural surpluses created an urban class freed from the necessity of food procurement while ration-paid workers ensured that production levels would be maintained (Adams 1972; Yoffee 1995). During the fourth millennium BC, urban society became increasingly stratified as individuals began to specialize in the various tasks necessary for the development of state-level

society. The surpluses also allowed for the creation of wide-ranging exchange systems from the Indus valley and Iranian plateau in the east, to the Nile valley in the west. Such trade networks were necessary in order to acquire raw materials not locally available such as minerals, metals, stone and timber (Moorey 1994). Thus, a new class of traders and craftsmen were born. Leaders of these urban centers began to establish their dominance over large areas of land, amassing great wealth through trade and conquest, and imposing their particular societal codes on an ever-widening territory. The name given to the lands of the southern Mesopotamian floodplain occupied by this urban society during this period was Sumeria, and the people who shared the language and culture of this region were known as Sumerians.

By the mid-fourth millennium, the first signs of writing appear in the archaeological record in the form of small clay tablets incised with pictographic representations of familiar objects (Kramer 1963). This pictographic script is known as cuneiform. Many scholars have observed that the emergence of writing systems coincided with an increase in the amount and complexity of trade going on in the urban centers, resulting in the necessity of maintaining accurate records of business transactions and other daily affairs (Kramer 1963).

While the use of copper tools and ornaments had long been known in northern Mesopotamia from as early as the sixth millennium BC (Moorey 1994), they remained largely in the realm of the upper classes as the softness of the metal precluded their use in everyday functions. Copper implements were also imported into southern Mesopotamia as early as 3500 BC by local elites. It was not until the

third millennium BC when metal-workers discovered the process of smelting copper with tin or lead to produce durable alloys, however, that the Bronze Age was ushered in (Moorey 1994). Use of such alloys did not reach their apogee until the second millennium BC when knowledge of advanced metallurgical techniques gradually spread throughout the region. During this period, bronze was increasingly used to make agricultural implements and weapons of war.

During the late fourth and early third millennium BC, the rulers of southern Mesopotamia expanded their political influence over a far-flung range of territory through both trade and conquest (King 1968; Drower and Bottéro 1971). This territory ran the length of the Tigris and Euphrates rivers, from modern Turkey and Syria in the north, to Iran and the Persian Gulf in the south. Later, the consolidation of power and territory under the rule of Sargon of Akkad (ca. 2300 BC) would draw the people of these diverse regions further into the sphere of southern Mesopotamian cultural influence (Gadd 1971b).

By the mid-third millennium BC, Sumerian culture had been increasingly permeated by Semitic-speaking peoples from the western fringes of the Near East (Kramer 1963; Gadd 1971a). These nomadic peoples were soon absorbed into the urban society of southern Mesopotamia, although they contributed much of their language and cosmology to the culture of the Sumerians. The name given to this syncretic culture is Akkadian, after the city of Akkad that was founded just north of the traditional lands of Sumer. Akkad gave rise to the most powerful ruling dynasties of the third millennium BC, culminating in the imperial rule of Sargon and his successors from ca. 2350 to 2150 BC (Gadd 1971b). This period also

coincided with a peak in population levels in southern Mesopotamia (Weiss et al. 1993). Sargon of Akkad consolidated imperial power in southern Mesopotamia and expanded it to encompass the rain-fed lands of northern Mesopotamia (known to him as Subir) as well, bringing the region further into the realm of Akkadian control. The motivations proffered by researchers for this expansion include desires for access to mineral resources (e.g. Weiss 1990a), or perhaps to secure agricultural surpluses for a growing population in the south (Adams 1981). A network of Akkadian administrative centers and an imperial tax system in Subir assured the flow of agricultural output and other materials into southern coffers (Weiss 1996). This situation was repeated in other regions of the Near East as Akkadian rulers sought to reinforce their power base through the establishment of political control and the accumulation of wealth on a scale previously unseen in the Near East (Oppenheim 1964). Two hundred years after the foundation of the first Mesopotamian empire, however, the Akkadian imperial system collapsed and a period of political decentralization ensued. This downfall of the Akkadian empire is traditionally (i.e. epigraphically) attributed to invaders from the eastern fringes known as the Gutians (Gadd 1971b).

The power vacuum left by the dissolution of the Akkadian empire remained until the establishment of a new regional hegemony under the Third Dynasty of Ur (ca. 2100-2000 BC). During this period, a vast imperial bureaucracy collected taxes and tribute from its subject states and continued the process of agricultural intensification and urbanization begun under the Akkadian system (Gadd 1971c). By attempting to maximize economic and political power,

however, the landscape was stretched to the limits of its agricultural capacity. At the same time, a continuous stream of populations from the north overwhelmed the already precarious urban situation in southern Mesopotamia and the system ultimately collapsed. During the course of the next millennium, the number of southern Mesopotamian settlements was reduced by 40 %, while settled areas were reduced by 77 % (Tainter 1988).

Northern Mesopotamia (Subir)

Evidence for cultural contact between southern and northern Mesopotamia appears first in the archaeological record during the fifth millennium BC with the discovery of southern 'Ubaid-style ceramics at several northern sites (Lloyd 1984). It is apparent that from this time onward, and perhaps earlier, cultural exchanges occurred on a somewhat continuous basis, although most researchers have tended to view these exchanges as relatively one-sided affairs (Weiss 1983); that is, that the development of northern Mesopotamian culture was heavily indebted to the culture of southern Mesopotamia.

Unlike the situation in southern Mesopotamia, the lands of northern Mesopotamia were more readily suited to agricultural production. Fertile soils and a relatively steady supply of rain alleviated the necessity of labor-intensive irrigation systems that posed such logistical problems in the south. Thus, settled agriculture began at an earlier date in the north than in the south. While the system of dry-farming that produced cereal crops such as barley and wheat in northern Mesopotamia has been shown to be highly productive (e.g. Weiss 1983; Wilkinson 1994), rainfall amounts were often unpredictable, leaving the region

vulnerable to drought. The earliest evidence for settled farming in northern Mesopotamia dates to the eighth millennium BC (Moorey 1994). Between this time and the early third millennium BC, the region was characterized by small farming settlements dispersed along the northern plains (Weiss 1983). Because of the region's susceptibility to drought, population levels and settlement sizes tended to remain small, thus avoiding overextension of the land's carrying capacity (Wilkinson 1994).

At approximately 2600 BC, however, the nature of subsistence farming and settlement in northern Mesopotamia began to change. Recent stratigraphic analyses of several sites on the Habur plains of northeastern Syria have indicated a major change in the pattern of northern Mesopotamian settlement during the mid-third millennium BC (Weiss 1985a; Weiss et al. 1993). This change is seen in the reorganization of settlements in the region and the transformation of previously small agricultural settlements into large planned cities, many of them fortified (Weiss et al. 1993). Excavations at Tell Leilan have revealed a metamorphosis from a simple village economy of the early third millennium BC, to a hierarchical centralized economy based on storage and redistribution of agricultural production and animal products. This scenario was repeated at several sites in the region, transforming the Habur plains into an increasingly urban environment, united economically, politically and militarily. This pattern of urbanization began approximately 300 years before the period of Akkadian expansion in the region, and suggests that the emergence of state-level

organization in northern Mesopotamia was largely indigenous (Senior and Weiss 1992).

When Sargon of Akkad and his successors extended their imperial domain to include the rain-fed lands of Subir between ca. 2350-2150 BC, urbanization was already well underway. Through the establishment of imperial administrative centers such as the one at Tell Brak, Akkadian control of the Habur plains and its agricultural infrastructure was maintained (Drower and Bottéro 1971; Weiss et al. 1993). Under the imperial system, agricultural production was intensified in order to provide food for Akkadian cities to the south. Archaeological and epigraphic evidence from this period suggests that this intensification was achieved through the use of ration-paid workers, a method commonly employed in the Akkadian economic system of southern Mesopotamia (Weiss et al. 1993; Yoffee 1995). In the later stages of the Akkadian period in northern Mesopotamia, the region was part of a thriving imperial economic system that supported wide-ranging trade networks and the construction of large-scale buildings and agricultural projects (Weiss et al. 1993).

By 2200 BC, however, dramatic changes occurred throughout the entire region of Mesopotamia. Archaeological and epigraphic evidence both attest to an abrupt collapse of state-level control and a period of political decentralization. Excavations have revealed a period of abandonment and inactivity at several sites from this period in northeastern Syria between 2200 and 1900 BC (Weiss and Courty 1993; Weiss et al. 1993).

Epigraphic sources from northern Mesopotamia after the fall of Akkad are quite sparse until the Third Dynasty of Ur period in ca. 2100 BC and only occur at a few sites in the Habur region (Bottéro 1971; Weiss 1985a). During the Third Dynasty of Ur, southern Mesopotamian scribes document an alarming influx of peoples from the north and the construction of a wall known as "The Repeller of the Amorites" to keep them out (Gadd 1971c; Weiss et al. 1993). The subsequent strain placed on the political and economic systems of southern Mesopotamia resulted ultimately in the disintegration of state-level society throughout Mesopotamia and a subsequent reduction in population levels and settlement sizes in the region (Tainter 1988).

Tell Leilan

Tell Leilan is an archaeological site located on the Habur plains of northeastern Syria on the bank of the Wadi Jarrah, a tributary of the Habur river, which, in turn, feeds into the Euphrates (Fig. 3.2). With its massive walls and acropolis commanding the surrounding plains, it is one of the largest extant sites in northern Mesopotamia (Weiss 1985a). Discovered in 1878 by Hormuzd Rassam, a Syrian archaeological agent for the British government, Tell Leilan was not systematically examined until one hundred years later when excavations began under the direction of Yale University archaeologist, Harvey Weiss. Beginning in 1978 with topographic surveys, consecutive excavation seasons have revealed a series of distinct cultural levels corresponding to the Bronze Age (Weiss 1985a). Combined with documentary evidence, occupation at Tell Leilan

is now believed to date from the mid-sixth to the early second millennium BC (Table 3.1) (Weiss 1985a; Weiss et al. 1993).

From the sixth millennium BC to the mid third millennium BC, Tell Leilan was a small, agriculturally-based settlement. During the Tell Leilan IIId period (~2600-2400 BC), however, settlement patterns throughout the Habur plains and the neighboring Assyrian steppe were altered dramatically (Weiss et al. 1993). Tell Leilan was transformed during this period into a large, well-planned city as part of the process of secondary state formation and urbanization witnessed throughout Mesopotamia, involving massive reorganization and relocation of settlements and populations (Adams 1981; Weiss 1983). Within 200 years, the site of Tell Leilan grew from a 15 hectare acropolis-based village settlement, to an approximately 100 hectare circumvallated site encompassing the surrounding lower plain (Weiss et al. 1993). Tell Leilan soon became part of a larger urban landscape on the Habur plains, along with Tell Brak and Tell Mozan, that controlled the production of agricultural and animal products through a hierarchical system of collection and redistribution (Weiss et al. 1993). United politically and economically, the cities of northern Mesopotamia were able to amass large armies capable of threatening the interests of the nascent Sumerian/Akkadian empire in southern Mesopotamia, eventually provoking Sargon of Akkad to annex the region in ca. 2300 BC (Drower and Bottéro 1971; Weiss 1985a).

The process of urbanization and state formation witnessed in third millennium BC northern Mesopotamia has increasingly been demonstrated as an

indigenous event, beginning some 300 years before the conquest of northern Mesopotamia by southern Mesopotamian imperialists. The excavations at Tell Leilan and surveys of sites in the surrounding area by Harvey Weiss have gone a long way in changing the prevailing views that northern Mesopotamian civilization developed in response to southern Mesopotamian influence. Certainly, contact and cultural exchanges between the two regions occurred well before the third millennium BC, but Weiss' research has shown that the flow of materials and ideas was not unidirectional.

According to Weiss and his colleagues (Weiss and Courty 1993; Weiss et al. 1993), Tell Leilan and many other major settlements in northern Mesopotamia were either abandoned or reduced in size between 2200 BC and 1900 BC. Evidence for this abandonment is demonstrated by the lack of ceramic assemblages at nearly all excavated sites throughout the Habur and Assyrian plains for the period between 2200 and 1900 BC. The size of the occupational area at Tell Brak was also reduced by half during this period (Weiss et al. 1993), while epigraphic sources from southern Mesopotamia suggest that other sites, such as Tell Mozan and Ninua, were occupied by remnant populations (Weiss 1985b; Weiss et al. 1993). In addition to traditional epigraphic and archaeological evidence, microscopic analysis of soil samples from this period at Tell Leilan and nearby sites have revealed higher levels of soil aridity (Weiss et al. 1993). Based on this analysis, Weiss and his colleagues have proposed a catastrophic climatic event as an explanation for this occupational hiatus ("Habur hiatus 1"), perhaps the result of volcanic eruption and subsequent desertification of cultivable land in

the region (Weiss et al. 1993). This temporal climatic change has also been documented in several areas in the eastern Mediterranean (Raban and Galili 1985; Amiran 1986; Frumkin et al. 1991; Otterman and Starr 1995). Such an event would have had disastrous consequences for the heavily urbanized region of northern Mesopotamia, which was highly susceptible to periods of extended drought (Wilkinson 1994). Weiss' research has led some scholars to reevaluate previously held theories on the collapse of state-level societies in the ancient Near East during the late third millennium BC (e.g. Issar 1995; Wright 1998), and stimulated debate on the roles climate change and the environment play in the development and collapse of ancient civilizations (e.g. Tainter 1988; Wilkinson 1994; Yoffee 1995).

Occupation at Tell Leilan resumed again in the early second millennium BC (Tell Leilan period I) and the site flourished for a time, according to Weiss (1985a, 1985b), as one of the capitals of "the Great Kingdom of Upper Mesopotamia" under the ancient name of Šubat Enlil (for a review of this period of north Mesopotamian history, see Kupper 1973). This last phase of occupation at Tell Leilan is historically documented between ca. 1900 and 1728 BC (Weiss et al. 1990).

Conclusion

Excavations at the Bronze Age site of Tell Leilan in northeastern Syria have shed new light on the origins and nature of state-level society in northern Mesopotamia during the third millennium BC. Weiss' research has demonstrated that the process of urbanization and state-formation in the region was largely

autonomous, occurring approximately 300 years before the arrival of southern Mesopotamian conquerors (Weiss et al. 1993). While cultural exchanges between the two regions have been demonstrated since at least the 'Ubaid period, recent archaeological investigations in northeastern Syria have shown that the social and economic trajectory of third millennium BC northern Mesopotamia was largely self-determined.

Despite these new advances in the history of northern Mesopotamia, Weiss' work has raised many new questions about the nature of the collapse of state-level society in northern Mesopotamia witnessed during the late third millennium BC. These new questions arise in light of new soil and climatological evidence that point to an environmental catastrophe that created long-lasting drought conditions, ultimately destabilizing the entire urban landscape of northern and southern Mesopotamia (Weiss et al. 1993). Weiss' research has profound implications for the study of ancient civilizations throughout the world, and their relationship with environmental, as well as socio-political forces.

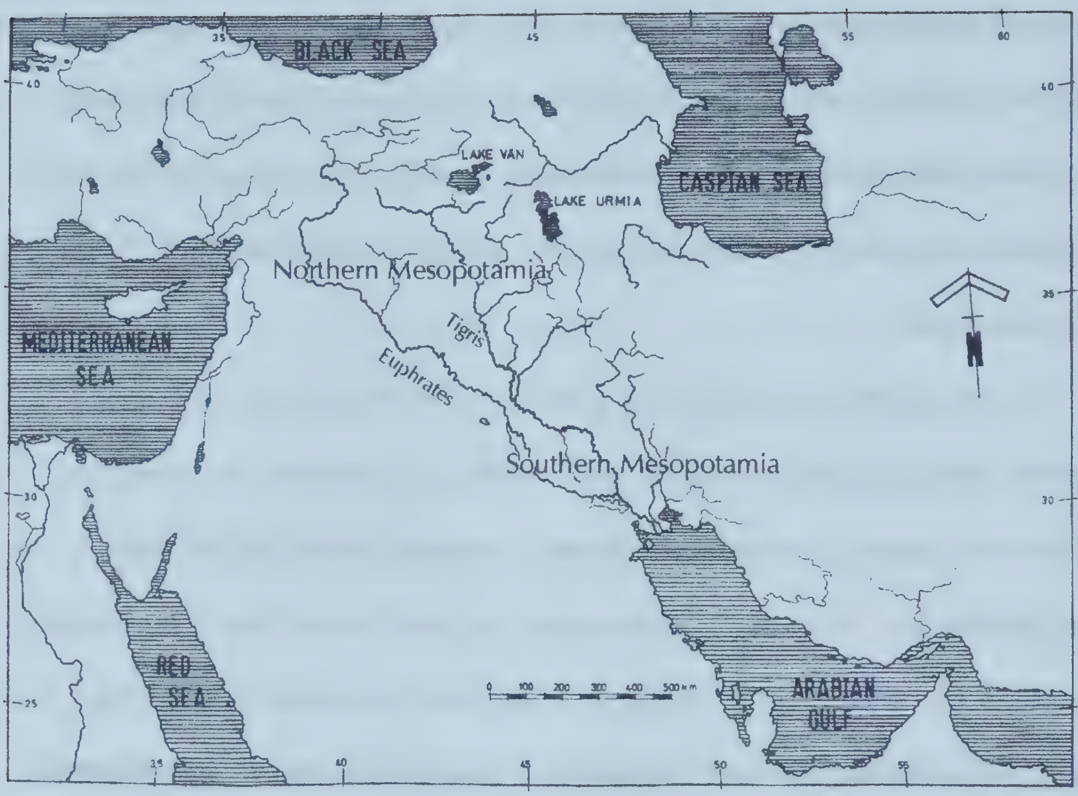

Figure 3.1. Map of Mesopotamia and surrounding area.

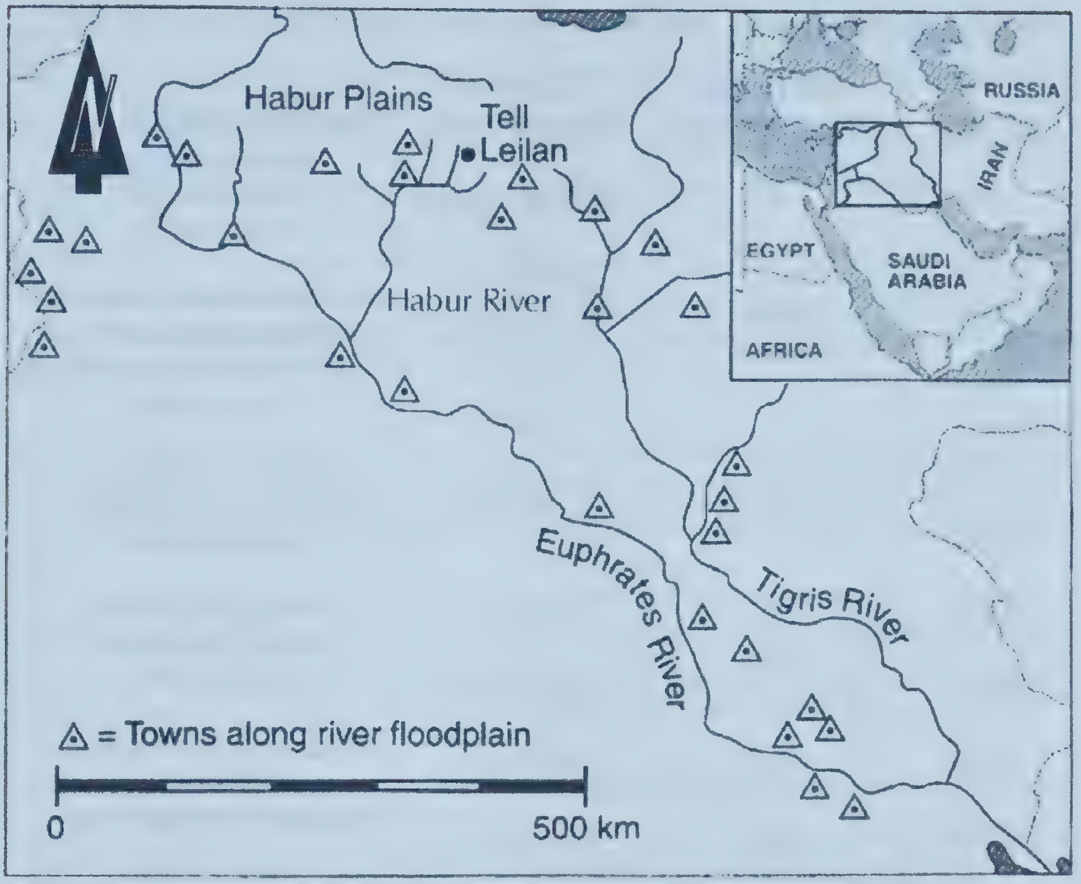

Figure 3.2. Syro-Mesopotamia circa 2500 BC (modified from Gibbons 1993).

Table 3.1. Third millennium BC Mesopotamian chronology (modified from Weiss et al. 1993).

ca. BC	Tell Leilan (Habur Plains)	Southern Mesopotamia	Developmental Stage
1900	I	Old Babylonian	Post-abandonment reoccupation of Mesopotamia
	....	....	
		Isin-Larsa	
2000	Habur Hiatus 1	....	Desertification of northern Mesopotamia and abandonment throughout Mesopotamia
		Ur III	
2100		....	
		Guti	
2200	....	....	Akkadian conquest of northern Mesopotamia; imperialization
	IIb	Akkad	
2300		....	
2400		ED IIIb	Consolidation of state power in northern Mesopotamia
	IIa		
2500		ED IIIa	
2600	IIId	Late ED II	Secondary state formation on the Habur Plains; massive urban expansion
2700	IIIc	Early ED II	
2800	IIIb	ED I	Structured cities in southern Mesopotamia; Smaller villages and towns throughout northern Mesopotamia
2900	IIIa	Jemdet Nasr	
3000	IV	Late Uruk	

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Chapter 4

Contributions to the Study of Tooth Morphology in Ancient Mesopotamia, Part I: Non-Metric Analysis of the Permanent and Deciduous Dentition of Bronze Age Tell Leilan, Syria

Introduction

While there have been numerous osteological analyses of ancient Near Eastern human remains, these works have focused primarily on metric and discrete trait analyses of the cranium and postcranial skeleton (e.g. Buxton and Rice 1931; Angel 1968; Cappieri 1969, 1970, 1972, 1973; Rathbun 1982, 1984). As well, a number of paleopathological studies of Near Eastern human remains have been published (e.g. Angel and Bisel 1986; Smith 1989). Analyses of ancient Near Eastern dentitions, while sparsely represented in the literature, have concentrated for the most part on pathology (e.g. Krogman 1940; Carbonell, VM 1966), and discrete traits (e.g. Dahlberg 1960; Rathbun 1972). Unfortunately, discrete trait, or non-metric, analyses of archaeological dentitions deriving from ancient Mesopotamia appear to be lacking. An explanation for this may be that the majority of excavations of human remains were conducted in the early first half of the twentieth century at such classic southern Mesopotamian sites as Kish (Mackay 1925; Watelin and Langdon 1934), and Ur (Wooley 1934), at a time when studies of the dentition (morphological or metric) were not generally considered essential components of osteological analysis. More recently, however, dental non-metric traits have been recognized as extremely valuable aids in assessing biological affinities between populations because these traits are

highly heritable, largely independent of environmental influence, and show significant variation between populations (Scott and Turner 1997).

The present study involves the morphological, or non-metric, analysis of human skeletal remains from the northern Mesopotamian site of Tell Leilan in Syria (Fig. 4.1). Since the early half of the twentieth century, changes in the political climate of the Near East have largely prevented archaeologists from continuing their research on ancient Mesopotamian sites, especially in Iraq. In recent decades, however, researchers have begun to explore the rich archaeological history of northern Mesopotamia (Weiss 1986), located in eastern Syria and northern Iraq, a region long ignored by archaeologists who, in the past, preferred to study the classical sites of the southern Iraqi floodplain. Despite a lack of more closely related comparative populations, dental non-metric trait data gleaned from studies of other regions and time periods of the Near East, and the world, can be used in a general comparison of trait variation between populations. This research, then, is intended as a further contribution to the study of non-metric dental morphology in ancient Mesopotamia.

Materials and Methods

Tell Leilan is an archaeological site located in northeastern Syria on the Habur plains. Excavations conducted by Yale archaeologist Harvey Weiss beginning in 1978 have revealed a series of distinct cultural levels corresponding to the Bronze Age (Weiss 1985). Occupation at the site is known from archaeological and documentary evidence to date from the mid-sixth to the early second millennium BC (Weiss 1985; Weiss et al. 1993). Situated on the fertile

Habur Plains of northeast Syria, Tell Leilan began as a small, rain-fed agricultural settlement, typical of many settlements in northern Mesopotamia (Weiss et al. 1993). Beginning in the mid third millennium BC (Leilan Period IIId), however, the emergence of a highly organized, state-level society at Tell Leilan and at other sites in the region (ancient Subir) is evident in the archaeological record (Weiss 1985; Weiss et al. 1993).

During period IIId and into period II, Subarian settlements like Tell Leilan expanded at an enormous rate, transforming a number of loosely structured villages into fortified, large-scale, planned cities(Weiss et al. 1993). Between 2300 and 2200 BC, northern Mesopotamia came under the control of the southern Mesopotamian ruler Sargon of Akkad and his successors. After 2200 BC, however, Weiss has discerned an occupational hiatus of approximately 300 years at Tell Leilan and other sites on the Habur Plains, which he attributes to a phase of aridification and subsequent drought in the region (Weiss et al. 1993). Occupational activity did not return to Tell Leilan until ca. 1900 BC (Leilan Period I) (Weiss 1985).

Both documentary and archaeological evidence attests to a period of state-level collapse throughout the Mesopotamian region, a collapse that has usually been described in terms of a social and political breakdown (reviewed by Weiss 1985; Weiss et al. 1993; Wright 1998). According to paleoclimatological and geoarchaeological data, however, a period of aridification may contributed to the abandonment of Tell Leilan, between 2200 and 1900 BC, and, to the collapse of the highly structured societies of Subir (northern Mesopotamia) and Sumer

(southern Mesopotamia) (Weiss et al. 1993). This dry phase was part of a more widespread climatic change Weiss believes occurred in the Eastern Mediterranean and Near East, and may have been responsible for the decline and collapse of several ancient civilizations throughout the region (Weiss et al. 1993; Wright 1998). Such environmental changes, documented by other researchers working in the eastern Mediterranean (e.g. Raban and Galili 1985; Amiran 1986; Frumkin et al. 1991; Otterman and Starr 1995), have forced some scholars to reevaluate older theories concerning the collapse of state-level Near Eastern societies during the third millennium BC (e.g. Issar 1995).

As part of a program of archaeological exploration at Tell Leilan, excavations by Weiss at Tell Leilan in 1979, 1980, 1985, 1987 and 1989 have yielded the fragmentary skeletal remains of twenty-one adult and thirty-eight subadult individuals. The skeletal material was subsequently sent to the University of Alberta Department of Anthropology for osteological analysis under the direction of Dr. Nancy Lovell. The present research is a part of a larger study being conducted on the collection as a whole (see: Haddow 2000; McKenzie 2000). Preservation of the skeletal remains is poor, especially of the crania, although the dentition, when present, is in excellent condition. However, of the permanent dentition, only 317 teeth out of a potential 672 were collected during excavation (Table 4.1), rendering 53% of the potentially observable dentition unavailable for study. Similarly, only 134 deciduous teeth were collected out of a possible 760 teeth (Table 4.2). Both tables include teeth that were unobservable for dental morphology due to extreme wear, breakage, etc. Because of the large

number of neonatal remains in the subadult sample (Haddow 2000), many of the deciduous teeth, in particular, are small, fragile and incompletely formed. As a result, the number of teeth scorable for one or more dental morphological trait, 253 for the permanent, and 89 for the deciduous, is a smaller subset of the total numbers presented in Tables 4.1 and 4.2. While there may be several possible explanations for the large number of missing teeth in the Tell Leilan sample, poor preservation is one that, I believe, can be readily discounted, given the excellent condition of the observable dentition. Ante-mortem tooth loss and lack of thorough collection procedures at the time of excavation (i.e. screening of grave fill) are more likely to have contributed to the incomplete nature of the dental sample.

The remains of both adults and subadults apparently derived from intramural burials found within house structures at various locations within the site (N. Lovell, pers. comm.). Not all the burials date to the same time period, however. The majority of the burials date to the era of increased urbanization witnessed in the latter half of the third millennium BC (Period IIa and IIb), although there are also some remains dating to the first half of the third millennium (Period IIIa-IIId), as well as the early second millennium BC (Period I). For the purposes of this study, however, all the remains will be treated as a cross-sectional sample from a single population. Furthermore, sexes are pooled because accurate sex assessment was extremely difficult due to the incomplete and fragmentary state of the skeletal remains. This should not affect the results, however, because several studies have observed that the only dental trait to

exhibit significant degrees of sexual dimorphism across diverse populations is the distal accessory ridge of the upper and lower canines (Scott 1977; Kaul and Prakesh 1981; Kieser and Preston 1981; Scott et al. 1983).

Permanent Dentition

Twenty-one individuals with permanent teeth were examined, and nineteen mandibular and twenty-three maxillary tooth-trait combinations were recorded. All available teeth were scored individually, but only the antimere exhibiting the highest degree of trait expression was used in the analysis, according to the individual count method (Scott 1977, 1980; Turner and Scott 1973). This technique accounts for the fluctuating asymmetric effects of environmental factors (Van Valen 1962a,b; Staley and Green 1971; Sciulli et al. 1979), and maximizes sample sizes in dental series obtained from archaeological contexts where remains are often fragmentary. All traits are described in the Arizona State University (ASU) Dental Anthropology System, which presents well-established criteria for scoring intra-trait variation (Turner et al. 1991). The traits were recorded with the aid of standardized ASU and Dahlberg Zoller Laboratory rank-scaled reference plaques (Fig. 4.2). The data collection took place over a period of one month. Intraobserver variation was assessed one year later by re-scoring 21 maxillary and 13 mandibular traits in a 14% sub-sample (three individuals) of the Tell Leilan adult population. These three individuals were chosen because their dentitions were the most complete and best-preserved, thus providing the maximum number of tooth-trait combinations for re-scoring. Scoring inconsistencies were observed in only 3% of either maxillary or

mandibular tooth-trait combinations. The majority of scoring inconsistencies occurred during observations of the hypocone on the maxillary molars, and of shoveling on both maxillary and mandibular incisors. None of these inconsistencies, however, affect the dichotomized expression frequencies presented in this study.

While variation in dental trait morphology was scored along a continuum of expression for the Tell Leilan permanent dental sample, trait expression was dichotomized into presence-absence for comparative purposes. In many cases, any degree of trait development was considered a positive expression. The exceptions are Lower Molar Cusp Number (LM1 and LM2) where presence = a score of 5 or greater; Deflecting Wrinkle (LM1) where presence = a score of 2 or greater; Tome's Root (LP1) where presence = a score of 3 or greater; Molar Root Number (LM1 and LM2) where presence = a score of 3 or greater and 2 or greater, respectively; Carabelli's Cusp (UM1) where presence = a score of 5 or greater; Metacone (UM1, UM2 and UM3) where presence = a score of 3 or greater; and Hypocone (UM2) where presence = a score of 3 or greater. The criteria for scoring trait presence or absence are given for each particular trait in Tables 4.3-4.4.

Deciduous Dentition

Of thirty-eight subadults with deciduous and mixed dentitions from the Tell Leilan sample, only thirteen were scorable for one or more tooth traits. Five maxillary and five mandibular morphological tooth-trait combinations were observed and recorded using the individual count method described above. The

scoring criteria for the deciduous dentition is based on the methods described by Kazuro Hanihara and co-workers (1963, 1968; Hanihara and Minimidate 1965). Mandibular traits include cusp number of the first and second molars, and presence on the second molar of the accessory cusps entoconulid, metaconulid and protostylid. The maxillary traits include shoveling of the central and lateral incisors, root apex deflection of the central incisor, Carabelli's cusp on the second molar, cusp number of the first molar, and hypocone size of the second molar. Intraobserver error was measured by repeated scoring of a 10% randomly selected sub-sample one year after the original scoring. Scoring inconsistencies occurred in 4% of mandibular and 3% of maxillary tooth-trait combinations. However, in none of the cases of scoring discrepancy did it exceed more than one grade. Rather than dichotomizing the data, the frequencies for each grade of a particular trait are presented.

Results

Tables 4.3 and 4.4 present the frequencies for each of the permanent dental traits observed in the mandible and maxilla respectively, while Tables 4.5 and 4.6 present the observed frequencies for the mandibular and maxillary deciduous traits respectively. The salient features of dental variability in the Tell Leilan permanent and deciduous dentitions are summarized below.

Permanent Dental Traits

On the mandibular molars, the Y-groove pattern is most common (91%) on M1, while in M2 it occurs much less frequently (20%). The +-groove is the second most common pattern, occurring 9% of the time on M1 and 60% of the

time on M2. The X-groove is the least common pattern observed in the mandibular molars. Five-cusped molars occur 66% of the time in M1 (ASU 5), 18% of the time in M2, and 22% of the time in M3. While the protostylid occurs in 53% of observable cases, the expression is confined to pit form only (ASU 1). When present, the hypoconulid, or cusp 5, tends to be larger on M1 than on M2. Four-cusped molars (ASU 4) tend to occur more frequently in M2 and M3. Accessory cusps are extremely rare. The entoconulid, or cusp 6, does not occur in any of the mandibular molars, while a small cusp 7 (ASU 2), the metaconulid, occurs once on M1 (6%), and once on M3 (9%).

Winging of the maxillary central incisors occurs in 40% of the sample. Twenty-five per cent of the Tell Leilan permanent maxillary central incisors exhibit semi-shoveling (ASU 3), while 50% exhibit faint or trace shoveling (ASU 1-2), and 25% show no evidence of shoveling whatsoever (ASU 0). Dichotomized into presence/absence statistics (presence = ASU 3-6), 25% exhibit the shovel-shaped trait. The expression of this trait, however, is limited to a maximum ASU score of 3, which indicates only a mild form of semi-shoveling. Eleven per cent of the permanent maxillary lateral incisors display semi-shoveling (ASU 4), 22% show trace shoveling, and 66% show no or trace shoveling (ASU 0-1). Dichotomized (presence = ASU 3-6), only 11% of the maxillary lateral incisors exhibit shoveling of some form. Double shoveling does not occur in any of the maxillary incisors. Interruption grooves occur more frequently on the maxillary lateral incisors (31% of the time), while occurring only 17% of the time on the maxillary central incisors.

Maxillary molars are morphologically conservative. In the first and second maxillary molars, large or very large forms of the metacone (distobuccal cusp) is present (ASU 4-5) 100% of the time. In the third molars, the metacone is slightly reduced, exhibiting an intermediate sized cusp 100% of the time (ASU 3.5). The hypocone, or distolingual cusp is fully expressed in the first molars, but exhibits a reduction in frequency in both M2 and M3. Trace cuspule and small cusp forms of the metaconule, or cusp 5, occur in 15% of the upper first molars (ASU 2-4). Fifteen per cent of the Tell Leilan permanent maxillary first molars exhibit the large free cusp form of Carabelli's trait (ASU 7), and 8% exhibit a small cusp without a free apex (ASU 5). None of the maxillary first molars exhibits the non-tubercle form (ASU 2-4), and 8% exhibit a groove (ASU 1). The majority of the maxillary first molars, 69%, show no evidence of Carabelli's trait. Of the upper first molars, 96% display no trace of the parastyle, while 14% exhibit a very mild expression of the trait in the form of a pit in or near the buccal groove (ASU 1). Because of the rarity of the parastyle, any expression of the trait on the buccal surface is considered as present. Dichotomized (presence = ASU 5-7), 23% of the Tell Leilan maxillary first molars exhibit the trait of Carabelli.

Deciduous Dental Traits

The frequencies of expression of deciduous mandibular and maxillary morphological traits are presented in Tables 4.5 and 4.6 respectively. Four-cusped deciduous lower first molars are the most common form, occurring 71% of the time, followed by five-cusped molars (29%). Three- and six-cusped forms of m1 do not occur. In the lower second molars, the five-cusped form occurs 75% of the

time, followed by the six-cusped variety (25%). Four- and three-cusped forms of m2 do not occur in the deciduous dental sample. Accessory cusps of the lower second molars, such as the entoconulid (cusp 6) and metaconulid (cusp 7), occur at the same frequency (37%). In both cases, the highest expression is a grade of 2, (occurring in both cusp forms 67% of the time). The protostylid is not observed in the deciduous teeth.

In the maxillary dentition, shoveling, when present, is consistently minimal. Trace shoveling (Hanihara score of 1) of the central incisors occurs in 56% of the sample, while in the lateral incisors, trace or semi (Hanihara 2) shoveling occurs in 52% of the sample. Trace shoveling also occurs in 29% of the maxillary canines. Deflection of the maxillary central incisor root occurs in both of the cases (2) that could be observed.

71% of the observable upper second molars exhibited some form of Carabelli's trait (Hanihara 1-7). Of these, 14% exhibit a shallow depression or groove (Hanihara 2), 14% exhibit a deep depression with lingual bulging (Hanihara 4), and 43% manifest the trait as a complete cusp (Hanihara 5 and 6). Three-cusped forms of the upper first molar, where the third cusp is the metacone (Hanihara 3M), are the rule. A large, well-developed hypocone (Hanihara 4) predominates in the upper second molar 86% of the time, while the well developed, but slightly reduced form (Hanihara 4-) occurs 14% of the time. No three-cusped upper second molars were observed.

Discussion

Among modern discrete trait analyses of skeletal populations, including dental non-metric studies, it is common to compare the trait expression frequencies of one population with those of several other populations, either synchronically or diachronically. Ideally, the comparative populations should be drawn from the regions nearest the study population, with a mind to a particular research problem. In the case of the region in question, Bronze Age Mesopotamia, research problems abound, such as the effects of hyper-urbanization on the gene frequencies of previously localized, rural populations during the third millennium BC, or the biological affinities of northern and southern Mesopotamian populations and their relationships to one another and to other populations in the region. Unfortunately, there is a distinct paucity of dental discrete trait studies conducted for ancient Mesopotamian populations when compared with the number of studies for other geographic regions such as east Asia and Australia (e.g. Hanihara et al. 1974; Smith et al. 1981; Mizoguchi 1985; Hanihara 1989; Birdsell 1993), south east Asia (e.g. Lukacs 1987; Lukacs and Walimbe 1984; Lukacs and Hemphill 1991), Europe (e.g. Smith 1977; Mayhall et al. 1982; Kaczmarek 1992) and the Americas (e.g. Dahlberg 1963; Kieser and Preston 1981; Scott et al. 1983).Until the publication of more dental morphological data conducted in the Near East occurs, especially for the early Mesopotamian civilizations, such avenues of inquiry will have to wait. For the present study, a comparison of several commonly observed permanent dental discrete trait expression frequencies of the Tell Leilan population to those of living and

archaeological Near Eastern populations will have to suffice. In order to ascertain the general biological affinities of the Tell Leilan population, however, a comparison of commonly observed permanent trait frequencies between Tell Leilan and the five major subdivisions of humankind (as defined by Scott and Turner 1997:170) is undertaken first. Because of the small size of the Tell Leilan deciduous sample and a lack of suitable studies for comparison, only the data for the permanent dentition will be compared at this time.

When compared with world-wide dental discrete trait frequency data for five maxillary and five mandibular permanent tooth-trait combinations, the geographical affinities of the Tell Leilan population become apparent. Table 4.7 presents this comparison, and includes the expression frequencies compiled by Scott and Turner (1997) from studies of the five major subdivisions of humankind (Fig. 4.3), Western Eurasian (Caucasoid), Sub-Saharan African (Negroid) , Sino-American, Sunda-Pacific and Sahul-Pacific (Mongoloid). As seen in Table 4.7, the Tell Leilan population most closely resembles the Western-Eurasian, and in some cases, Sunda-Pacific, subdivisions in terms of frequency. The exceptions are UPM1 and UM2 root number, where the Tell Leilan population is slightly closer in frequency to Sub-Saharan Africans. As represented by dental discrete trait frequencies then, the Tell Leilan population appears to exhibit mainly Western Eurasian or Caucasoid characteristics; an unsurprising conclusion given the geographical location of Tell Leilan.

When the Tell Leilan permanent dental discrete traits are dichotomized into presence or absence statistics, the frequency of expression for 5 maxillary

and 4 mandibular traits can be compared with those obtained in other studies in order to better understand the relationship of the Bronze Age Tell Leilan population to other populations in the Near East. While not closely related either temporally or geographically, several dental discrete trait analyses of Near Eastern living and archaeological populations (Fig. 4.4), when combined with similar data for Tell Leilan, may provide a starting point for a basic comparison of dental discrete trait expression frequencies in the Near East. The Near Eastern comparative set consists of a prehistoric population from Ra's al-Hamra, a coastal site in Oman (Macchiarelli 1989), and two living populations; one a Jewish population from Yemen and another, a settled Bedouin population from Israel (Rosenzweig and Zilberman 1967, 1969). The studies of living populations were conducted through the observation of individual dental casts obtained from the study groups and scored in the usual manner (Rosenzweig and Zilberman 1967, 1969). In addition, three other Near Eastern dental discrete trait studies are discussed in relationship to Tell Leilan. They are not included in the tables, however, either because the original authors did not provide exact figures for their trait data, or because the manner in which the trait was scored is unclear.

Table 4.8 presents the comparison of nine tooth-trait combination expression frequencies observed in the Tell Leilan population with those obtained from similar studies of living and archaeological Near Eastern populations. The scoring criteria for each of the traits is the same given in Tables 4.3 and 4.4. It can be seen from Table 4.8 that shoveling occurs more frequently among the living Israeli Bedouin and Yemenite Jewish populations than in the archaeological Tell

Leilan and Ra's al-Hamra populations. The frequency of expression of cusp and tubercle forms of Carabelli's trait ranges from 22% to 49% between the Yemenite, Tell Leilan and Bedouin populations respectively, while the same forms are not observed at all in the Ra's al-Hamra population. The greatest reduction of hypocone size is observed in the modern Bedouin population, while Tell Leilan resembles the modern Yemenite group in terms of hypocone size. The Y-groove pattern on the lower first molars is also more common in the archaeological populations (i.e. Tell Leilan, Ra's al-Hamra) than in the living populations (i.e. Israeli Bedouin, Yemenite Jews), while on the lower second molars, Tell Leilan more closely resembles the living populations. Despite this comparison, however, little of detail can be said about the relationship of Tell Leilan to the comparative populations because of the great distances, both temporally and geographically, between them. Generally, the living populations appear to exhibit higher frequencies of Mongoloid-associated traits (i.e. UI1 shoveling, UM2 hypocone size, LM2 Y-groove pattern), than the Tell Leilan population which exhibits frequencies not inconsistent with Caucasoid patterning. The Ra's al-Hamra population, however, exhibits both Caucasoid and Negroid forms. The higher frequencies of Mongoloid characteristics in the living Near Eastern populations may reflect interbreeding between Caucasoid and Mongoloid populations in the region as a result of the movements of people between Asia and Europe over thousands of years.

In addition to the data provided in Table 4.8, Carbonell's analysis of cusp and tubercle forms of Carabelli's trait in the permanent dentition of the Bronze

Age inhabitants of the southern Mesopotamian city of Kish (1960) provides an expression frequency of 24%, while Tell Leilan's frequency of expression for the same trait is 23%. Rathbun's analysis of the dentition from Iron Age Hasanlu in northern Iran (1972) however, shows no evidence of Carabelli's trait. Finally, Dahlberg's analysis of the permanent dentition from Neolithic Jarmo, Iraq (1960) describes cusp and tubercle forms of Carabelli's trait on the upper first molars, and reduction of the hypocone in the second and third upper molars. Because of the extremely small size of the Jarmo population (N=7 adults) however, Dahlberg does not provide exact figures for these trait frequencies.

Conclusion

Non-metric analysis of the permanent and deciduous dentition of the northern Mesopotamian Bronze Age site of Tell Leilan, when compared with similar analyses conducted world wide and in the Near East, reveals a relatively consistent affiliation with Western Eurasian, or Caucasoid populations, although certain traits share affinities to both Western Eurasian and Sunda-Pacific populations. When compared with living and archaeological Near Eastern populations, the Tell Leilan sample appears to exhibit higher frequencies of Western Eurasian traits than the living Near Eastern populations. These later populations exhibit somewhat higher frequencies of stereotypically Mongoloid traits (i.e. UI1 shoveling, UM2 hypocone size) which may be the result of cumulative gene flow between continental populations since ancient times. Indeed, the Near East has served as a thoroughfare for the movements of populations between Africa, Asia and Europe for millennia.

Because of the small sample size, the Tell Leilan skeletal material was treated as if it were a cross-section of a once-living population at a particular point in time, rather than as it is, an assemblage of human remains dating from between the early third to the early second millennium BC. Had the sample been larger, an analysis of changes in dental trait expression frequencies at Tell Leilan during the course of the third millennium BC may have shed some light on the changing face of the Tell Leilan population at a time when hyper-urbanization was transforming the region. More dental non-metric studies of living and archaeological dentitions in the Near East, using standardized recording procedures (i.e. The ASU system), are required, especially for the ancient civilizations of Mesopotamia. More research will ultimately lead us to a better understanding of such complex issues as migration and urbanization, and, hopefully, in a better understanding of the biological relationships of ancient Near Eastern peoples to one another and to the world.

Figure 4.1. Map of Near East showing location of Tell Leilan and regions of ancient Mesopotamia.

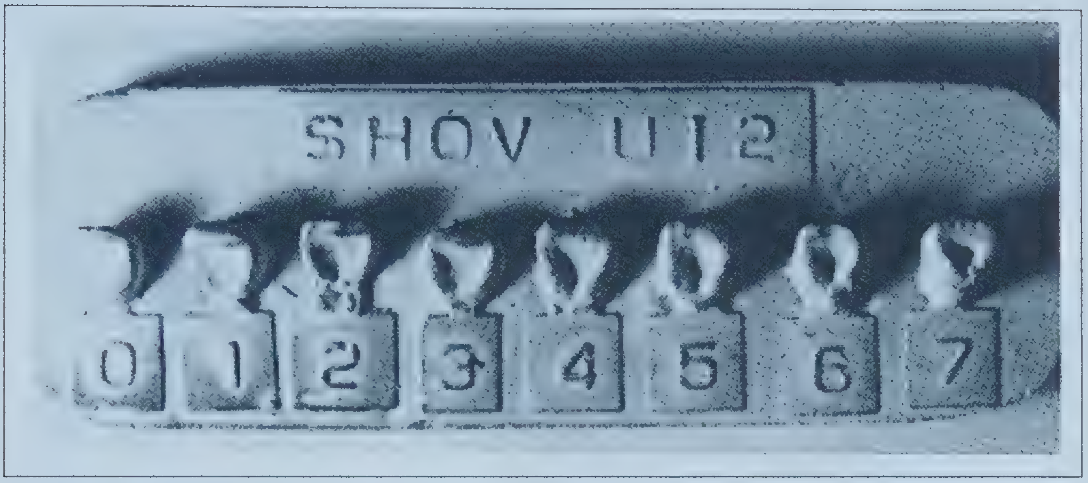

Figure 4.2. Example of an ASU dental plaque showing different grades of shoveling in the permanent upper central incisor.

Figure 4.3. World map showing the five major subdivisions of humankind (modified from Scott and Turner 1997).

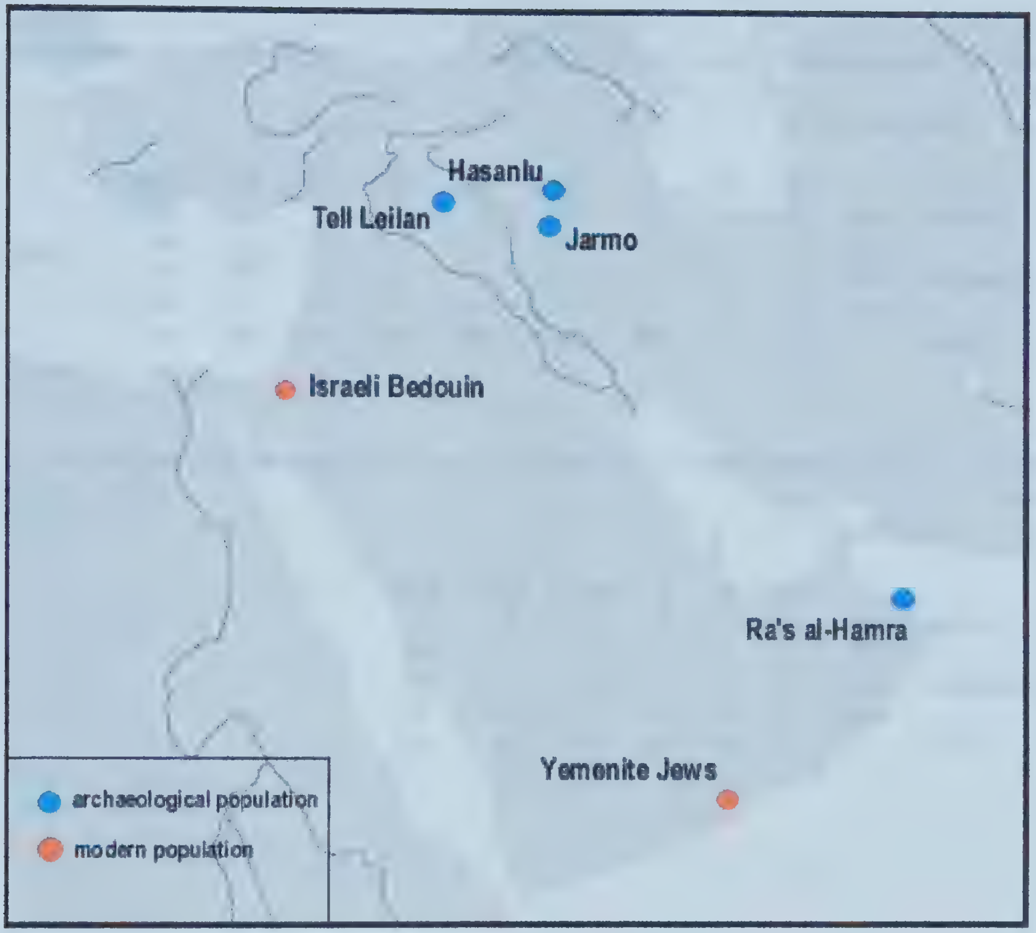

Figure 4.4. Map of Near East showing locations of archaeological and living comparative populations in relation to Tell Leilan.

Table 4.1. Permanent dental sample from Tell Leilan (including those teeth unobservable for dental
morphology).

		I1	I2	C	P1	P2	M1	M2	M3	Total
Maxilla	right	9	8	8	6	7	11	9	8	**66**
	left	12	13	11	11	12	13	10	6	**88**
Mandible	right	10	12	10	11	10	13	11	6	**83**
	left	7	10	9	11	11	13	11	8	**80**
Total		**38**	**43**	**38**	**39**	**40**	**50**	**41**	**28**	**317**

Table 4.2. Deciduous dental sample from Tell Leilan (including those teeth unobservable for dental
morphology).

		I1	I2	c	m1	m2	Total
Maxilla	right	6	7	4	6	8	**31**
	left	8	8	6	7	7	**36**
Mandible	right	8	7	4	10	6	**35**
	left	5	5	4	10	8	**32**
Total		**27**	**27**	**18**	**33**	**29**	**134**

Table 4.3. Frequency of Tell Leilan permanent mandibular dental traits.
[**n**=number of teeth expressing trait; **N**=number of observable teeth;
%=frequency of expression (n/N)]

Trait	Tooth	n	N	%
Lingual Cusp # (+ = ASU 2-9)	LP2	2	5	40%
Anterior Fovea (+ = ASU 2-4)	LM1	3	4	75%
Y-Groove Pattern	LM1	10	11	91%
+-Groove Pattern	LM1	1	11	9%
Y-Groove Pattern	LM2	2	10	20%
+-Groove Pattern	LM2	6	10	60%
X-Groove Pattern	LM2	2	10	20%
Molar Cusp # (+ = ASU 5-6)	LM1	10	15	66%
Molar Cusp # (+ = ASU 5-6)	LM2	2	11	18%
Deflecting Wrinkle (+ = ASU 2-3)	LM1	2	4	50%
Protostylid (+ = ASU 1-7)	LM1	8	15	53%
Cusp 5	LM1	9	14	64%
(+ = ASU 1-5)	LM2	2	10	20%
Cusp 6 (+ = ASU 1-5)	LM1	0	17	0%
Cusp 7 (+ = ASU 2-4)	LM1	1	17	6%
Canine Root # (+ = ASU 2)	LC	0	10	0%
Tome's Root (+ = ASU 3-5)	LP1	3	8	38%
Molar Root # (+ = ASU 3)	LM1	0	4	0%
Molar Root # (+ = ASU 2-3)	LM2	5	6	83%

Table 4.4. Frequency of Tell Leilan permanent maxillary dental traits. [**n**=number of teeth expressing trait; **N**=number of observable teeth; **%**=frequency of expression (n/N)]

Trait	Tooth	n	N	%
Winging (+ = ASU 1)	UI1	2	5	40%
Shoveling (+ = ASU 3-6)	UI1	2	8	25%
	UI2	1	9	11%
Labial Convexity (+ = ASU 2-4)	UI1	8	9	89%
Double Shoveling (+ = ASU 2-6)	UI1	0	11	0%
	UI2	0	11	0%
Interruption Groove (+ = ASU +)	UI2	4	13	31%
Tuberculum Dentale (+ = ASU 2-6)	UI2	2	11	18%
Distal Accessory Ridge (+ = ASU 2-5)	UC	0	2	0%
Metacone (+ = ASU 3-5)	UM1	13	13	100%
	UM2	11	11	100%
	UM3	7	7	100%
Hypocone (+ = ASU 3-5)	UM1	13	13	100%
	UM2	6	10	60%
	UM3	4	7	57%
Cusp 5 (Metaconule) (+ = ASU 1-5)	UM1	2	13	15%
Carabelli's (+ = ASU 5-7)	UM1	3	13	23%
Parastyle (+ = ASU 1-5)	UM1	2	14	14%
	UM2	0	10	0%
	UM3	0	7	0%
Enamel Extensions (+ = ASU 1-3)	UM1	0	10	0%
Premolar Root # (+ = ASU 2-3)	UP1	5	9	56%
Upper Molar Root # (+ = ASU 3-4)	UM2	5	6	83%

Table 4.5. Frequency of Tell Leilan mandibular deciduous dental traits.

Cusp number

grade	m1 n	m1 %	m2 n	m2 %
6	0	0	2	25
5	2	29	6	75
4	5	71	0	0
3	0	0	0	0
Total:	**7**	**100**	**8**	**100**

Accessory cusps (m2)

grade	Entoconulid (C-6) n	Entoconulid (C-6) %	Metaconulid (C-7) n	Metaconulid (C-7) %	Protostylid n	Protostylid %
0	5	63	5	63	8	100
1	1	12	1	12	0	0
2	2	25	2	25	0	0
3+	0	0	0	0	0	0
Total:	**8**	**100**	**8**	**100**	**8**	**100**

Table 4.6. Frequency of Tell Leilan maxillary deciduous dental traits.

Shovel Shape

Grade	i1 n	i1 %	i2 n	i2 %
0 (absent)	4	44	4	44
1 (trace)	5	56	4	44
2 (semi)	0	0	1	12
3 (full)	0	0	0	0
Total:	**9**	**100**	**9**	**100**

Root Deflection (i1)

Grade	n	%
absent	0	0
present	2	100
Total:	**2**	**100**

Carabelli's Trait (m2)

Grade	n	%
0	2	29
2	1	14
4	1	14
5	1	14
6	2	29
Total:	**7**	**100**

Cusp Number m1

Grade	n	%
2	0	0
3M	6	100
3H	0	0
4	0	0
Total:	**6**	**100**

Hypocone size (m2)

Grade	n	%
3+A	0	0
3+B	0	0
4-	1	14
4	6	86
Total:	**7**	**100**

Table 4.7. Comparison of commonly observed dental traits between Tell Leilan and major subdivisions of humankind.

	Population					
Tooth Trait*	**Tell Leilan**	**Western Eurasia**	**Sub-Saharan Africa**	**Sino-America**	**Sunda-Pacific**	**Sahul-Pacific**
Shoveling UI1	25%	19%	12%	68%	32%	6%
Interruption Grooves UI2	31%	38%	13%	48%	31%	15%
Hypocone UM2	60%	74%	100%	81%	93%	11%
Carabelli's UM1	23%	17%	15%	10%	17%	12%
Cusp 5 UM1	15%	19%	41%	22%	33%	51%
5 or more cusps LM1	66%	88%	98%	97%	99%	91%
5 or more cusps LM2	18%	16%	55%	54%	53%	37%
Y-Groove LM2	20%	11%	45%	10%	15%	17%
UPM1 Root Number	56%	47%	50%	19%	42%	39%
UM2 Root Number	83%	66%	81%	52%	71%	71%

*scoring criteria same as used in Tables 4.3 and 4.4.

Table 4.8. Comparison of commonly observed dental traits between Tell Leilan and living and archaeological Near Eastern populations.

	Population			
Tooth Trait*	**Tell Leilan**	**Ra's al-Hamra**	**Israeli Bedouin**	**Yemenite Jews**
Shoveling UI1	25%	0%	42%	47%
Carabelli's UM1	23%	0%	49%	22%
Metacone UM2	100%	100%	100%	100%
Hypocone UM1	100%	100%	100%	98%
Hypocone UM2	60%	86%	31%	64%
Y Groove Pattern LM1	91%	100%	70%	53%
Y Groove Pattern LM2	20%	80%	7%	9%
5 or more cusps LM1	66%	55%	84%	85%
5 or more cusps LM2	18%	0%	7%	0%

*scoring criteria same as used in Tables 4.3 and 4.4.

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Chapter 5

Contributions to the Odontometric History of Ancient Mesopotamia, Part II: Metric Analysis of the Permanent and Deciduous Dentition of Bronze Age Tell Leilan, Syria

Introduction

While there have been numerous publications of osteological analyses of ancient Near Eastern human remains, these works have focused primarily on metric and discrete trait analyses of the cranium and postcranial skeleton for the purposes of understanding biological affinities (e.g. Buxton and Rice 1931; Angel 1968; Cappieri 1969, 1970, 1972, 1973; Rathbun 1982, 1984). As well, a number of studies have been published on the paleopathology of Near Eastern human remains (e.g. Angel and Bisel 1986; Smith 1989). Published analyses of ancient Near Eastern dentitions, while sparsely represented in the literature, have concentrated for the most part on pathology (e.g. Krogman 1940; Carbonell, VM 1966) and morphology (e.g. Dahlberg 1960; Rathbun 1972). While odontometric studies of Near Eastern dentitions have also been conducted (e.g. Rosenzweig and Zilberman 1967, 1969; Macchiarelli 1989), analysis of dentitions from the Bronze Age civilizations of ancient Mesopotamia appear to be lacking. One reason for this may be that excavations of human remains at such classic sites as Kish (Mackay 1925; Watelin and Langdon 1934), and Ur (Wooley 1934), were conducted in the early first half of the twentieth century, a time when studies of the dentition (metric or morphological) were not generally considered essential components of osteological analysis. Since that time, changes in the political climate of the Near East have largely prevented archaeologists from continuing

their research at many ancient Mesopotamian sites, especially in Iraq. In recent decades, however, researchers have begun to explore the rich archaeological history of northern Mesopotamia (Weiss 1986), located in eastern Syria and northern Iraq, a region long ignored by archaeologists who, in the past, preferred to study the classical sites of the southern Iraqi floodplain. As a result of excavations conducted in northeastern Syria in the last quarter of the twentieth century, a new set of archaeological human remains is available for analysis.

The present study involves the odontometric analysis of human skeletal remains from the northern Mesopotamian site of Tell Leilan in modern Syria (Fig. 5.1). Odontometric data gleaned from studies of other regions and time periods of the Near East are used in a general comparison of diachronic dental size variation. Such comparisons of odontometric data, especially of crown areas, allow researchers to quantitatively examine the phenomenon of hominid dental reduction, both synchronically and diachronically. To date, documentation of dental reduction trends based on odontometric observation of archaeological populations has been achieved in a number of areas of the world for specific periods of time (e.g. post-Paleolithic Asia: Brace 1978, Lukacs and Hemphill 1991; Upper Paleolithic-Mesolithic Europe: Frayer 1977, 1978). More work in regions and time periods of history previously unexamined by dental anthropologists will enable researchers to more accurately understand the evolutionary processes involved in hominid dental reduction. While hominid dental reduction is one of the most widely observed and reported trends in the study of human evolution (Kieser 1990), theories on the mechanisms behind these

trends are numerous and hotly debated (e.g. Brace 1963, 1964, 1978; Macchiarelli and Bondioli 1984, 1986; Brace, et al 1987, 1991; Calcagno 1989; Gibson and Calcagno 1989). However, it is not the purpose of this research to settle this debate. The present study is intended as a contribution to the odontometric history of Mesopotamia and as a summary compilation and comparison of previously conducted odontometric work as it relates to the phenomenon of dental reduction within the ancient Near East.

Materials and Methods

The archaeological site of Tell Leilan is located on the fertile Habur plains of northeastern Syria. Occupied from the mid-sixth millennium BC, the site became one of the three major urban centers of Subir during the mid-third millennium BC as part of the phenomenon of complex state society emergence that occurred throughout northern and southern Mesopotamia (Weiss et al. 1993). During the Tell Leilan IIb period (~2300-2200 BC), the imperial interests of the southern Mesopotamian ruler Sargon and his successors, brought Tell Leilan and the rest of Subir under Akkadian domination (Gibbons 1993; Weiss et al. 1993).

According to Harvey Weiss (Weiss et al. 1993), the archaeologist responsible for excavations at the site, Tell Leilan was abandoned approximately 2200 BC due to severe climatic change for approximately three hundred years, perhaps as a result of volcanic eruption and subsequent desertification of cultivable land in the region. This temporal climatic change has been documented in a number of areas in the eastern Mediterranean (Raban and Galili 1985; Amiran 1986; Frumkin et al. 1991; Otterman and Starr 1995), and has led some

scholars to reevaluate previously held theories on the collapse of state-level societies in the ancient Near East during the late third millennium BC (Issar 1995).

Excavations at Tell Leilan began in 1978 under the direction of Weiss, with the cooperation of the Directorate-General of Antiquities in Damascus (Weiss 1985). The remains of twenty-one adult and thirty-eight subadult humans were recovered over five field seasons between 1979 and 1989. Presently, the remains are curated at the Department of Anthropology, University of Alberta. Preservation of the skeletal remains is poor, especially of the crania, although the dentition, when present, is in excellent condition. However, of the permanent dentition, only 317 teeth out of a potential 672 were collected during excavation (Table 5.1), rendering 53% of the potentially observable dentition unavailable for study. Similarly, only 134 deciduous teeth were collected out of a possible 760 teeth. Table 5.2 presents the Tell Leilan deciduous dental sample, including teeth unobservable for measurement. While there may be several possible explanations for the large number of missing teeth in the Tell Leilan sample, poor preservation is one that, I believe, can be readily discounted, given the excellent condition of the observable dentition. Ante-mortem tooth loss and lack of thorough collection procedures during the time of excavation (i.e. screening of grave fill) are more likely to have contributed to the incomplete nature of the dental sample, especially for the deciduous teeth, which are small and easily missed. In addition, because of the high numbers of neonatal and infant remains in the sample, many of the deciduous teeth had either not completely formed, or not begun to form at

all. Of the 317 permanent teeth collected, 260 were observable for one or more tooth crown measurement (e.g. mesiodistal and/or buccolingual crown diameter). The remaining 57 teeth were unobservable for measurement as a result of either incomplete eruption, extreme occlusal wear, or postmortem crown breakage. Of the 134 deciduous teeth collected, only 81 were observable for one or more tooth crown measurement.

The majority of the remains date to the urban period of third millennium occupation (~2600 to ~2200 BC), although they range in date from the early third millennium BC to the early second millennium BC (N. Lovell, pers. comm.). Due to the small sample sizes and relatively homogenous cultural context, however, for this study all the remains will be treated as a sample from a single population.

All tooth crown measurements for the Tell Leilan dentition were taken by the author with a Helios needle-point dial caliper, calibrated to 0.05 mm. Measurements were rounded to 0.1 mm. Two measurements, maximum buccolingual (BL) diameter and maximum mesiodistal (MD) diameter (Fig. 5.2) were taken for each tooth as outlined by Moorrees (1957) and Wolpoff (1971a) and summarized by Mayhall (1992, 2000). Crown area (CA) was calculated by multiplying the mesiodistal and buccolingual measurements for each tooth (Wolpoff 1971b). Intraobserver error was assessed by remeasurement of a 10% randomly selected subset of the original sample, yielding a mean intraobserver measurement difference of 0.060 and a standard deviation of 0.22. Such values are well within the ranges reported by other researchers for similar studies (Wolpoff 1971a; Lukacs 1985; Lukacs and Hemphill 1991). Paired sample t-tests

were used to assess BL and MD asymmetry of permanent right and left antimeres. Tabulation and statistical analysis of the data were completed using Excel (Microsoft Corporation, 1991) and Systat software (SYSTAT, Inc., 1990-1992), respectively. This test was not used for the deciduous sample because of the extremely small sample size. As a result, the deciduous data is presented for both right and left antimeres. The data are presented with the sexes pooled because the incomplete and fragmentary state of the skeletal remains rendered accurate assessment of sex for the Tell Leilan sample very difficult.

Total crown area (TCA), the sum of mean cross-sectional crown areas for all upper and lower teeth on one side of the jaw, and molar crown area (MCA), the sum of the mean cross-sectional crown areas for upper and lower posterior teeth on one side of the jaw, serve as the primary units of comparison for diachronic interpretation of permanent tooth size variation in the ancient Near East. TCA and MCA values for the comparative samples were obtained either directly from the original published data or calculated based on the original mean mesiodistal and buccolingual crown diameters.

Results

Permanent Dentition

The first step in analyzing the dentition is to assess dental asymmetry between right and left antimeres. Through the use of paired samples t-tests, the mean differences between right and left measurements for each tooth type were generated (Table 5.3). While there is a slight degree of directional asymmetry

(with eleven of sixteen teeth from the left side on average slightly larger than the right side), this difference is not statistically significant ($p = 0.05$).

A second value, the standard deviation (sd) of mean differences between right and left antimeres or RMS (Root Mean Square), described by Smith et al. (1982), provides another useful indicator of the extent of dental asymmetry. For the Tell Leilan sample, however, the standard deviation, or RMS, does not display the consistent patterning of smaller to larger values moving distally within a given tooth class as observed by Lukacs and Hemphill (1991). The small sample size of paired observations for right and left antimeres is most likely to blame for this, as well as for the large standard deviation of certain teeth (e.g. third molars). Smith, et al. (1982:283) state that RMS values in the area of 0.80 are not uncommon when sample sizes of $n < 100$ are used. The mean RMS (sd) of buccolingual and mesiodistal diameters for all teeth provides a general indication of asymmetry for the dentition as a whole (Lukacs and Hemphill 1991). For the Tell Leilan permanent dental sample, the mean RMS is 0.40. This figure is higher than the mean RMS scores observed by other researchers (e.g. RMS= 0.23 and 0.24, Lukacs and Hemphill 1991). Again, the very small sample size of paired observations, however, may explain the high mean RMS value when compared with other studies. This precludes the utilization of the mean RMS value for the Tell Leilan permanent dentition in comparative analysis of interpopulational dental asymmetry.

Because of the statistically insignificant nature of left-right antimeric differences, crown diameters and areas are presented for the left side only,

substituting values from the right side of the dental arcade for missing left values when available. This increases the sample size of observations for certain teeth, thus increasing the utility of the statistical results. Tables 5.4 and 5.5 present the mean BL and MD crown diameters and crown areas for the Tell Leilan permanent dentition, sexes pooled, and include sample size and standard deviation. All measurements are in millimeters for crown diameters (BL and MD) and millimeters squared for crown areas (CA).

Deciduous Dentition

Tables 5.6 and 5.7 present the mean BL and MD crown diameters and crown areas for the Tell Leilan deciduous dentition. All measurements are in millimeters for crown diameters (BL and MD) and millimeters squared for crown areas (CA). Because of the extremely small size of the Tell Leilan deciduous dentition, statistical analyses of antimeric asymmetry would be of dubious utility. For this reason, the data are presented for both right and left antimeres in Tables 5.6 and 5.7.

Discussion

Numerous odontometric studies have utilized the total crown area (TCA), and/or the molar crown area (MCA) as a figure for comparing tooth crown size variation (e.g. Brace 1980; Lukacs 1985; Brace et al. 1987). Wolpoff (1971b) states that crown areas most closely approximate the total functional occlusal size of the dentition. Thus, crown area is the actual trait which natural selection acts upon (Brace 1980); making TCA and MCA, as single discrete values, highly useful for comparing interpopulational variation in tooth size.

Permanent Dentition

For this study, the total and molar crown areas of the Tell Leilan permanent dental sample (TCA= 1189 mm^2; MCA= 668 mm^2) are compared with the total and molar crown areas for several archaeological hominid populations in the Near East (Fig. 5.3), beginning in the Middle to Upper Paleolithic and ending in the Iron Age, as a general illustration of tooth size reduction in the region. Although it would be preferable to limit the diachronic comparison to sites that are specifically located within the area of Tell Leilan (northern Mesopotamia), very few odontological studies have been conducted in the region. For this reason, crown area values for the nearest available archaeological populations (Iran, Iraq, Israel and Turkey) have been utilized in order to flesh out the comparison.

Table 5.8 presents TCA, MCA, time period and site location for each archaeological population. All data are taken from sex-pooled samples. All total and molar crown area values for the comparative samples were calculated from the original published MD and BL crown diameters, or from the original mean crown areas given for each tooth class. One exception is the TCA of the modern European sample, for which the total crown area value is provided by Brace (1978). In the case of the Neanderthal sample from Shanidar, crown areas for the anterior dentition could not be determined due to extreme occlusal wear (Trinkhaus 1978), and thus the molar crown area (MCA) serves as the primary comparative value. While the Tell Leilan crown diameters were recorded by measuring the *maximum* mesiodistal breadth for each tooth, it is not explicitly stated in a number of the odontological studies used for this comparison whether

this same methodology was followed or whether they measured the breadth between the mesial and distal contact facets of the molar teeth in the manner of Hrdlička (1924) and others. Such differences in measurement technique may result in smaller or larger crown diameter values observed depending on the method employed. As a result, summed crown area values may be affected. This must be taken into consideration when looking at the comparative data.

As illustrated in Table 5.8, the overall trend in interpopulational tooth size variation is one of gradual reduction over time, beginning in the Upper Paleolithic with the Skhul/Qafzeh hominids and the Shanidar Neanderthals, and ending with the modern European population. One sample, the Copper Age Alaca Höyük site in Turkey, however, does not follow this trend. When compared with the other values given in this study, the Alaca Höyük population has the smallest TCA, smaller even than the modern European sample. Many factors, including method of measurement and the biological affinities of the Alaca Höyük population may account for these difference. Despite this, the overall trend is in accord with observations made by numerous researchers working in other regions of the world (e.g. Dahlberg 1960, 1963; Sofaer 1973; Brace 1978; Lukacs and Hemphill 1991). If we examine the values from northern Mesopotamia specifically (i.e. Shanidar, Jarmo and Tell Leilan), it can be seen that a reduction in molar crown area of about 100 mm^2 has taken place in the time span between the Shanidar and Jarmo samples (approx. 55 000 yrs), giving an average molar crown area reduction rate of 0.002 mm^2 per year. The average molar crown area reduction rate between Jarmo and Tell Leilan (a span of approximately 4500 yrs) is 0.002 mm2 per year;

an identical rate. For the Israeli samples (Skhul/Qafzeh, Natufian, Abou Gosh), a molar crown area reduction rate of 0.001 mm^2 per year is given for the 90 000 year interval between the Skhul/Qafzeh and Natufian samples, while the rate of reduction in the 4000 year interval between the Natufian and Abou Gosh samples is 0.009 mm^2 per year; approximately nine times faster than the Skhul/Qafzeh-Natufian rate of reduction. One explanation for the increased rate of reduction during the post-Paleolithic period in Israel may have to do with the increasingly sedentary agricultural lifestyle of the population and the resulting structural changes to the dentition wrought by the shift in subsistence modes. The same increase in dental reduction rates should be expected for the Tell Leilan region during the same period (assuming that the population in that region was undergoing the same changes in subsistence modes); however, this is not the case. Such discrepancies, however, generally agree with findings by other researchers who have noted that the rate of reduction in hominid dentition has varied both spatially and temporally over the course of human evolution (e.g. Calcagno 1989; Macchiarelli and Bondioli 1986; Reddy 1992). Factors such as genetic drift and the blending of geographically diverse populations over time often obscure or complicate our understanding of human dental reduction, especially in the post-Paleolithic.

When examining individual tooth types for differential variation in size, Dahlberg (1963) and Sofaer (1973) maintain that the upper central incisors and the first molars can be considered genetically "stable" or "key" teeth in that they resist variation in tooth size to a greater extent than the more distal, or later

developing teeth within their respective tooth class (i.e. incisor, premolar and molar). In order to test this hypothesis, the difference in per cent tooth size variation (increasing or decreasing) between upper and lower first molars and the later developing upper and lower second molars are compared using the hunter-gatherer Shanidar Neanderthal sample and the much later agriculturalist Tell Leilan sample. The mean crown area of the Tell Leilan upper first molars exhibit a 3.2 % reduction from their Shanidar equivalent as compared with a 28.8 % reduction of the upper second molars. For the lower first molars, however, there is actually a 2.6 % increase in size from the Shanidar sample to the Tell Leilan sample, while the lower second molars are reduced by 15.5 %. Unfortunately, crown areas were not available for the Shanidar anterior teeth and thus cannot be compared with values for the Tell Leilan sample. The results of the comparison of differential molar tooth size variation is, however, in accord with the hypothesis that within a given tooth class, the extent of tooth size reduction will increase moving distally (Sofaer 1973). This comparison can also be made between Tell Leilan and the earlier agriculturalist Jarmo sample. In this instance, the Tell Leilan upper first molars are 2.4 % larger than the Jarmo equivalent, while the Tell Leilan upper second molars are reduced by 11.5 %. There is no variation in size between Leilan and Jarmo lower first molars. The Tell Leilan lower second molars are 4.5 % larger however, than the lower second molars from Jarmo. The degree of differential variation within the upper incisor tooth class between the Tell Leilan and Jarmo samples is not as evident as with the molar class. Both the upper central and upper lateral incisors from the Tell Leilan sample exhibit an

approximate increase of 9 % from their Jarmo counterparts with the central incisor varying only slightly less in size than the lateral.

Many scholars have debated the mechanisms of dental reduction. Most scholars agree, however, that an overall reduction in tooth crown size should be observed in populations as they move from nomadic hunting and gathering subsistence modes to more sedentary agricultural modes (e.g. Dahlberg 1963; Sofaer 1973). Indeed, studies have shown that the rate and extent of human dental reduction was at its most profound during the Post-Pleistocene, precisely the time period during which the transition in subsistence modes occurred (Macchiarelli and Bondioli 1986; Calcagno 1989; Reddy 1992).

While reduction in the size of the dentition also occurred -at a slower rate- during the Pleistocene, it is believed by some researchers that this reduction was related to an overall reduction in body size or robusticity, especially in the masticatory apparatus and facial skeleton in general (Macchiarelli and Bondioli 1986; Brace, et al. 1991). Others have argued against a direct correlation between body size and tooth size, proposing instead a scenario in which selective pressures, favoring larger or smaller teeth depending on specific environmental conditions affecting dental health, act as the primary mechanism of reduction (Calcagno 1989; Calcagno and Gibson 1991). Such conditions may have included dietary toughness and/or abrasiveness. Early cultural advancements such as food preparation techniques (i.e. the use of fire to cook raw plant and animal foods), pottery, increasingly sophisticated tools and changes in diet may also have played a role in selecting for smaller tooth sizes. Given the lack of odontological

research, it is not, however, within the scope of this paper to determine the exact mechanisms of dental reduction for the region of Northern Mesopotamia.

Presently, there are no sources of modern Near Eastern odontometric studies suitable for comparative purposes. While Rozensweig and Zilberman (1969) did publish a metric analysis of the dentition of modern Bedouin in Israel, their observations (i.e. crown diameters) did not include the third molars. Thus, the TCA for a modern European population (Brace 1978) is included in Table 5.8 as an illustration of the extent of dental size reduction since the Middle Paleolithic. Studies of modern human populations have shown that the smallest tooth crown dimensions today are observable in Europeans and certain Asian populations (Dahlberg 1963; Lukacs 1985). Some researchers have argued that this is because these regions were some of the earliest sites of sedentary agricultural development, and consequently have had the longest amount of time for dental reduction to occur (Brace 1978; Reddy 1992). Because the region of Mesopotamia is also one of the earliest sites of agricultural development, the same small tooth dimensions should be expected for modern Near Eastern populations. However, in all cases, extenuating factors such as genetic makeup, the migration of peoples and genetic drift will also play a role, the extent of which may be hard to determine at this point in time. It is hoped that increased research will clarify these issues.

Deciduous Dentition

Only a few studies have focused on the odontometry of the deciduous dentition (e.g. Lukacs 1981; Lukacs et al. 1983), and, with the exception of

Konigswald (1967), and Smith (1978), rarely have evolutionary trends in the deciduous dentition been documented. Smith's study (1978) does, however, document rates of deciduous dental reduction similar to permanent rates in Middle and Upper Pleistocene to Post-Pleistocene and recent Near Eastern populations, mainly in Israel. Table 5.9 presents the Tell Leilan deciduous TCA, 497 mm^2, in comparison with Smith's (1978) deciduous TCA data for several Near Eastern populations beginning in the Epipaleolithic and ending in modern times. It can be seen from Table 5.9 that, as with the permanent dentition, a distinct reduction trend can be observed over time.

Conclusions

Metric analysis of the permanent and deciduous dentition of the northern Mesopotamian Bronze Age site of Tell Leilan, when compared with odontological work from varying periods within the Near East, reveals and confirms the pattern of hominid dental size reduction observed worldwide since the Middle Paleolithic. The total crown area (TCA) for the Tell Leilan permanent dental sample, 1189 mm^2, and 497 mm^2 for the deciduous sample, places this archaeological population at the smaller end of the crown area scale for the Near East; smaller in size than nearby Paleolithic and Neolithic populations, and slightly larger than more recent populations and the modern samples. Larger dental samples from a wider variety of sites in ancient Mesopotamia will eventually allow for a more detailed documentation of metric dental trends in this region and time period of the Near East.

Figure 5.1. Map of Near East showing location of Tell Leilan and regions of ancient Mesopotamia.

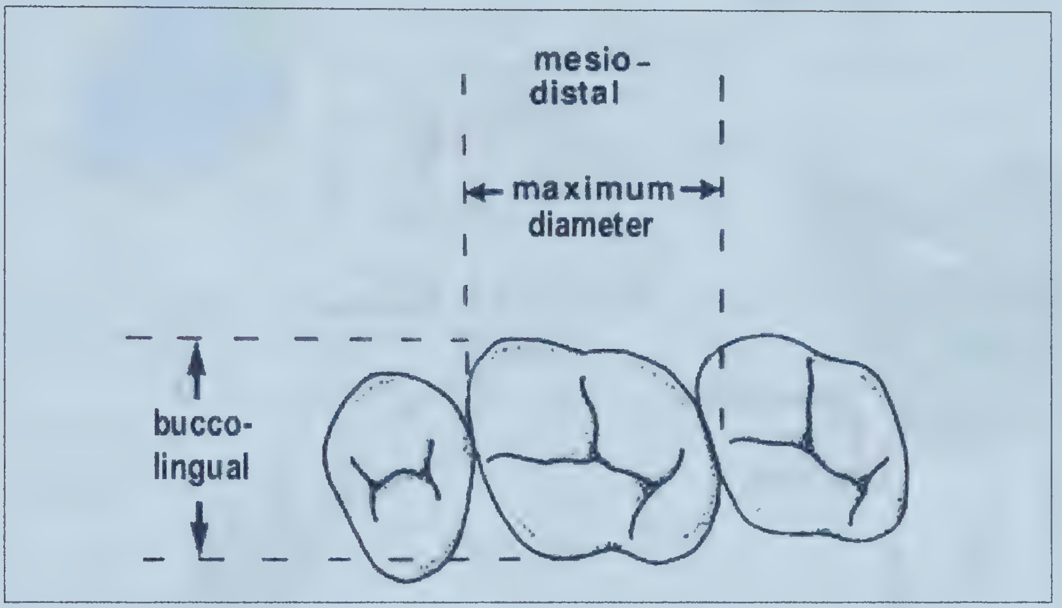

Figure 5.2. Illustration of the methods for determining the mesiodistal (MD) and buccolingual diameters (modified from Mayhall, 2000)

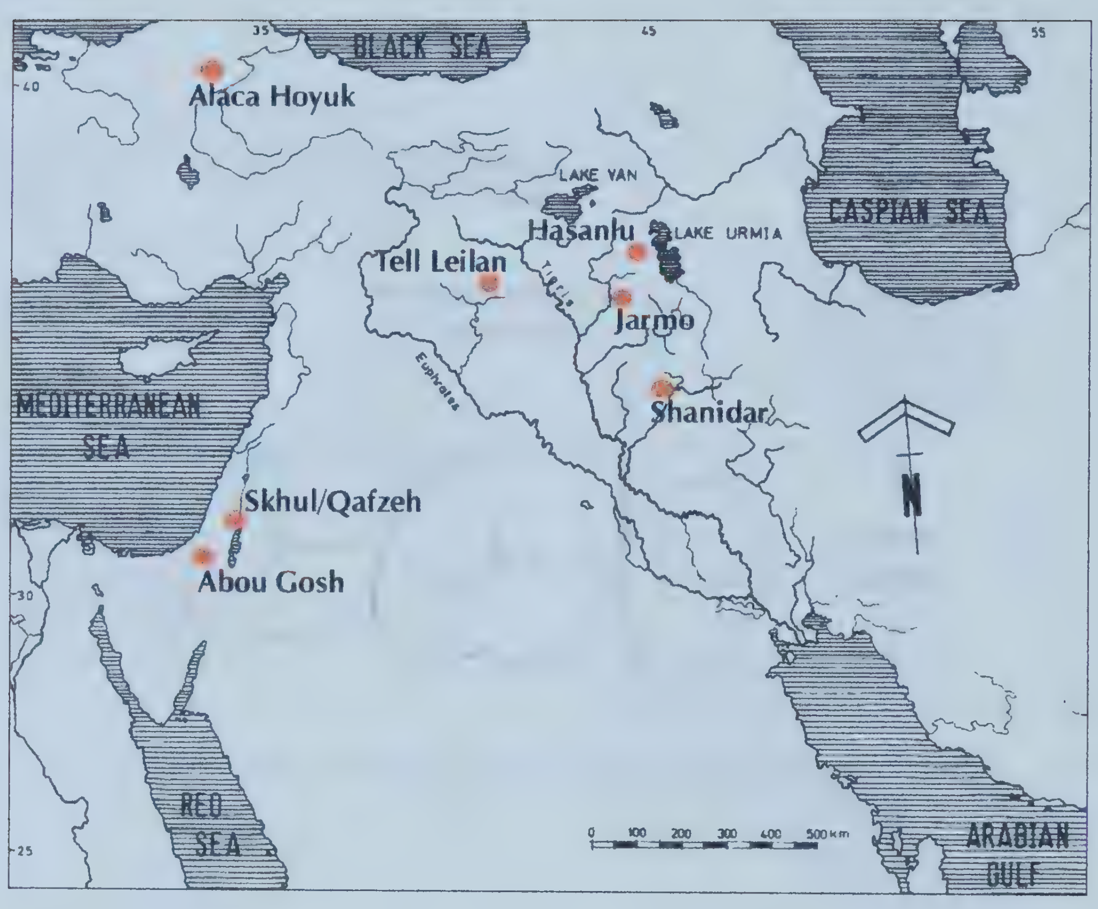

Figure 5.3. Map of Near East showing sites used in comparison of TCA and MCA. Natufian material derives from several sites in the Levant (Dahlberg 1960).

Table 5.1. Number of teeth in the Tell Leilan permanent dental sample (including those teeth unobservable for measurement).

		Ic	Il	C	P1	P2	M1	M2	M3	Total
Maxilla	right	9	8	8	6	7	11	9	8	**66**
	left	12	13	11	11	12	13	10	6	**88**
Mandible	right	10	12	10	11	10	13	11	6	**83**
	left	7	10	9	11	11	13	11	8	**80**
Total		**38**	**43**	**38**	**39**	**40**	**50**	**41**	**28**	**317**

Table 5.2. Number of teeth in the Tell Leilan deciduous dental sample (including those teeth unobservable for dental measurement).

		I1	I2	c	m1	m2	Total
Maxilla	right	6	7	4	6	8	**31**
	left	8	8	6	7	7	**36**
Mandible	right	8	7	4	10	6	**35**
	left	5	5	4	10	8	**32**
Total		**27**	**27**	**18**	**33**	**29**	**134**

Table 5.3. Mean difference in Tell Leilan permanent tooth crown diameters and areas for right and left antimeres. None of the differences are significant p = 0.05.

	Buccolingual			**Mesiodistal**			**Crown Area**		
tooth	n	mean diff.	sd	n	mean diff.	sd	n	mean diff.	sd
max.									
Ic	6	-0.033	0.234	6	0.083	0.376	6	0.395	2.763
Il	7	-0.100	0.374	6	-0.200	0.322	6	-1.840	4.763
C	6	-0.033	0.258	7	0.229	0.364	6	0.155	2.219
P1	5	0.160	0.428	5	-0.280	0.432	5	-1.506	6.395
P2	6	-0.030	0.379	6	0.050	0.138	6	-1.563	3.095
M1	4	-0.050	0.342	4	-0.025	0.236	4	-0.817	4.582
M2	4	0.175	0.532	3	-0.330	1.079	3	-0.267	8.482
M3	4	0.150	0.265	4	-0.325	0.640	4	-1.620	4.441
mand									
Ic	4	0.225	0.435	5	-0.040	0.297	4	1.388	4.301
Il	5	0.0001	0.265	5	0.380	0.563	5	2.334	3.957
C	5	0.140	0.207	6	-0.050	0.226	5	0.314	0.952
P1	8	-0.037	0.320	8	-0.200	0.460	8	-1.801	4.714
P2	6	-0.350	0.599	6	-0.167	0.398	6	-3.897	4.547
M1	6	-0.067	0.339	6	-0.217	0.299	6	-3.010	5.122
M2	6	-0.133	0.197	6	-0.383	0.471	6	-5.535	6.043
M3	3	-0.100	0.580	3	0.100	0.700	3	-0.383	9.046

n=number of observable teeth

Table 5.4. Mean crown diameters of permanent left teeth from Tell Leilan (in mm).

	Maxilla						Mandible					
	Buccolingual			Mesiodistal			Buccolingual			Mesiodistal		
Tooth	n	Mean	sd	n	Mean	sd	n	Mean	sd	n	Mean	sd
Ic	12	7.38	0.37	12	8.58	0.64	6	6.05	0.21	7	5.16	0.76
Il	11	6.77	0.60	11	6.46	0.42	10	6.36	0.37	11	5.48	0.76
C	10	8.63	0.46	10	7.30	0.45	9	7.92	0.53	10	6.71	0.37
P1	11	9.07	0.48	10	6.75	0.42	12	7.89	0.50	12	6.76	0.41
P2	11	9.07	0.66	11	6.53	0.43	12	8.04	0.81	12	7.03	0.62
M1	14	11.93	1.73	14	10.48	0.95	12	10.63	0.52	12	11.28	0.70
M2	11	10.85	1.07	10	9.49	1.10	11	10.43	0.47	12	11.22	0.80
M3	7	10.89	1.18	8	9.30	0.61	5	9.96	0.92	5	10.38	0.92

n=number of observable teeth

Table 5.5. Mean crown area for Tell Leilan permanent left dentition in (mm^2).

	Maxilla			Mandible		
Tooth	n	Mean	sd	n	Mean	sd
Ic	12	63.36	6.35	6	29.79	3.46
Il	11	43.94	6.44	10	33.99	4.82
C	9	64.02	5.13	9	52.60	3.83
P1	10	61.38	6.14	12	53.35	4.89
P2	11	59.43	7.81	12	58.69	10.46
M1	14	125.71	25.60	12	120.10	11.01
M2	10	103.59	19.04	11	115.57	11.01
M3	7	99.37	10.30	5	103.92	17.83

TCA left side (total crown area)= 1189.01 mm^2.

Table 5.6. Mean crown diameters for Tell Leilan deciduous dental sample (in mm).

		Maxilla						Mandible					
		Buccolingual			Mesiodistal			Buccolingual			Mesiodistal		
Tooth	side	n	Mean	sd	n	Mean	sd	n	Mean	sd	n	Mean	sd
Ic	R	2	5.25	0.21	2	6.75	0.07	4	4.28	0.93	4	4.58	0.79
	L	2	5.25	0.21	2	6.70	0.14	3	3.87	0.50	3	4.37	0.81
Il	R	2	5.15	0.21	2	5.80	0.00	3	4.70	0.61	3	5.23	0.72
	L	2	4.80	0	2	5.45	0.21	3	4.60	0.56	3	5.67	1.25
C	R	3	5.97	0.65	3	6.73	0.86	4	5.70	0.28	4	6.03	0.15
	L	4	6.20	0.29	4	6.95	0.19	3	5.80	0.20	3	5.93	0.15
M1	R	4	8.75	0.17	4	7.55	0.58	4	7.20	0.27	4	8.75	0.31
	L	4	8.73	0.11	4	7.53	0.68	4	7.15	0.47	4	8.68	0.33
M2	R	4	9.85	0.66	4	9.53	0.17	4	8.73	0.15	4	10.53	0.29
	L	4	10.00	0.39	4	9.73	0.33	4	8.88	0.26	4	10.55	0.29

Table 5.7. Mean crown areas for Tell Leilan deciduous dental sample (in mm^2).

		Maxilla			Mandible		
Tooth	side	n	Mean	sd	n	Mean	sd
Ic	R	2	35.45	1.06	4	20.05	7.43
	L	2	35.15	0.64	3	17.13	5.39
Il	R	2	29.85	1.20	3	24.73	5.66
	L	2	26.15	1.06	3	26.53	8.98
C	R	3	40.53	9.43	4	34.35	2.01
	L	4	43.13	3.20	3	34.43	1.67
M1	R	4	60.05	8.57	4	63.08	4.65
	L	4	65.83	8.14	4	62.13	5.94
M2	R	4	93.75	4.72	4	91.80	1.55
	L	4	97.28	5.19	4	93.60	2.67

Table 5.8. Temporal variation in tooth size of selected Near Eastern archaeological populations.

Sample name	Site location	Cultural Association	TCA (mm^2)	MCA (mm^2)	Source
Skhul/Qafzeh	Israel	Middle Paleolithic	1494*	780	*Vandermeersch 1981 (Qafzeh only) Trinkhaus 1978
Shanidar Neanderthals	N. Iraq	Upper Paleolithic	-	773	Trinkhaus 1978
Natufian	Israel	Mesolithic	1272	722	Dahlberg 1960
Jarmo	N. Iraq	Neolithic	1246	679	Dahlberg 1960
Abou Gosh	Israel	Neolithic	1240	685	Arensburg et al. 1978
Tell Leilan	**N. Syria**	**Bronze Age**	**1189**	**668**	**this study**
Hasanlu	Iran	Iron Age	-	605	Rathbun 1972
European	various	Modern	1161	-	Brace 1978
Alaca Höyük	Anatolia	Chalcolithic/ Copper Age	1138	643	Senyürek 1952

TCA = Total Crown Area.
MCA = Molar Crown Area.

Table 5.9. Temporal variation in deciduous tooth size of selected Near Eastern living and archaeological populations

Cultural Association	TCA (mm^2)	Source
Epipaleolithic	550	Smith 1978
Neolithic	504	Smith 1978
Chalcolithic	459	Smith 1978
Bronze Age (Tell Leilan)	**497**	**present study**
Iron Age	474	Smith 1978
Recent	454	Smith 1978

TCA = Total Crown Area

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Chapter 6

Conclusions

While studies of Near Eastern skeletal material have been conducted, analyses of human dentitions, especially for the civilizations of ancient Mesopotamia, are few and far between (Calcagno 1989). This is largely due to the fact that many of the extant studies of ancient Mesopotamian skeletal material were conducted in the early part of the twentieth century, a time when morphometric analyses of the dentition were not considered essential aspects of osteological investigations. Since then, the number of skeletal samples deriving from ancient Mesopotamian sites has declined considerably as a result of changes in the political climate in the Near East, especially in Iraq. The recent skeletal sample from the Bronze Age site of Tell Leilan, however, provides new data for the study of dental anthropology in ancient Mesopotamia.

The skeletal sample from Tell Leilan consists of the remains of twenty-one adult and thirty-eight subadult individuals, dating from the early third to the early second millennium BC, and corresponding to the Bronze Age. Despite excellent preservation, the Tell Leilan dental sample is, regrettably, not as complete as it should be. Roughly 50 % of the permanent teeth were not recovered. While some of the missing teeth may be attributed to agenesis and ante-mortem tooth loss as a result of dental disease, the observable maxillae and mandibles indicate that ante-mortem tooth loss, at least of the anterior teeth, was not a serious problem. Since anterior teeth are single rooted, they are easily displaced from the jaws in the post-mortem environment, and their absence from

the sample is quite plausibly due to the excavation techniques employed and the excavators' understanding of the importance of the recovery of all skeletal and dental elements. This underscores the value of having of a trained human osteologist in the field, even on projects that do not involve the excavation of formal cemeteries.

Morphometric analysis indicates that the Tell Leilan permanent and deciduous dentitions exhibit largely Western Eurasian, or Caucasoid, morphological characteristics, and a Total Crown Area (permanent = 1189 mm^2; deciduous = 497 mm^2) that is slightly larger than more recent Near Eastern and modern European dentitions. When compared with several Near Eastern and European populations, the TCA for the Tell Leilan dental sample documents dental reduction over time, which is consistent with the pattern of dental reduction observed in other regions and time periods of the world.

The results of the non-metric analysis are not surprising, given the location of Tell Leilan and the traditional association of the Near East with "Caucasoid" populations. However, due to the lack of a true, large skeletal series at Tell Leilan spanning hundreds of years, and of more closely related skeletal samples in general, specific questions of microevolutionary changes in morphological crown and root trait frequencies within the population at Tell Leilan, and of the biological relationship between Tell Leilan and other Near Eastern populations cannot be addressed at this time. Similar concerns arise with the metric data, in that, a lack of odontometric studies for this geographic region prevent a more detailed analysis of the pattern of human dental reduction in the Near East. With

increased access to, and excavation of, the sites of ancient Mesopotamia, larger and more numerous skeletal samples will provide researchers with the material for more comprehensive studies. These studies will increase our understanding of the biological and evolutionary history of the people of this region.

References Cited

Calcagno JM (1989) Mechanisms of Human Dental Reduction: A Case Study From Modern Nubia. Lawrence: University of Kansas Publications in Anthropology No. 18.